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FLIGHT MODEL PRESHIPMENT REVIEW DATA PACKAGE VOLUME III - SYSTEM DAT PART B NASA STI FACILITY Article IV -3A

Greenbelt, Maryland 20771 **CONTRACT NAS 5-24200**

Prepared for **GODDARD SPACE FLIGHT CENTER**

THEMATIC MAPPER

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PRESHIPMENT REVIEW DATA PACKAGE.

THEMATIC MAPPER FLIGHT MODEL

N83-26131

CSCL 14B G3/43

Barbara Research Center)

SYSTEM DATA Final Report (Santa

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VOLUME 3,

SEPT 1982 THEMATIC MAPPER

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HS 236-0019-1679



Presented for
GOODARD SPACE FLIGHT CENTER
Grossbor, Maryland 20771
CONTRACT NAS 5-24289

SEPT 1982

FLIGHT MODEL
PRESHIPMENT REVIEW
DATA PACKAGE
VOLUME III - SYSTEM DATA
PART A

Article IV - 3A



Hughes Ref No. 04529 •

THEMATIC MAPPER FLIGHT MODEL PRESHIPMENT REVIEW VOLUME III SYSTEM DATA

TABLE OF CONTENTS

3.0	SYSTEMS INTEGRATION AND TEST	SECTION
	Vibration and Acoustical Noise Tests	3.1
	Integration Tests. Introduction	3.2
	IA01 TEST - Bands 1 to 4 Coarse & Fine Focus.	3.2.1
	Interconnect Verification Test.	
	IAO3 TEST - Bands 5 and 7 Coarse Focus and	3.2.2
	Baffle Check.	
	IA04 TEST - Focus Verification, Rotational	3.2.3
	Alignment & Band-to-Band Regis-	
	tration.	
	IAO6 TEST - Verification Telescope Orientation to SMA Pivot Axis.	3.2.4
	IA07 TEST - Electronic Module Integration	3.2.5
	ACO2 TEST - Radiometric Calibration	3.2.6
	AC22 TEST - Spectral Matching	3.2.7
	ACO7 TEST - Spatial Coverage	3.2.8
	BL07 TEST - Radiometric Calibration of Calibrator	3.2.9
	BL10 TEST - Radiometric Calibration - Band 6	3.2.10
	BL12 TEST - Coherent Noise	3.2.11
	BL16/17 TEST - Dynamic Square Wave Response	3.2.12
	BL19/20 TEST - Band-toBand Registration, Geometric Accuracy, Self Induced Vibration	3.2.13
	Thermal Vacuum Tests	3.3
	EMI/EMC	3.4
	Mass Properties	3.5

THEMATIC MAPPER
FLIGHT MODEL
PRESHIPMENT REVIEW
VOLUME III
SYSTEM DATA
TABLE OF CONTENTS

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(Continued)

4.0	LIENS	SECTION
	Summary of Liens	4.0
	Failure Reports	4.1
	Requests for Deviation/Waiver	4.2
	Engineering Change Proposal Status	4.3
	Non-Conforming Material Report	4.4

3.0 SYSTEMS INTEGRATION AND TEST

Data contained in this section is segregated by test performed on the Flight Model Thematic Mapper.

Each section contains lists of references to all pertinent documents relating to the test, including test specifications and plans; and copies of the test results from which the summary charts of Volume I were derived.

3.1 VIBRATION TEST & ACOUSTICAL NOISE TEST

Test Summary: HS236-8110 S.G. Oxley HS236-8119 R.A. Amador

6

Test Specification: TP32015-609 TM Vibration Test Procedure TP32015-623 TM Acoustics Test Procedure

Reference Documentation: HS236-2154 Revision to Specification GSFC 400.8-D-201, 9 June 1981

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ORIGINAL PAGE IS OF POOR QUALITY

INTERNAL MEMORANDUM

TO: J. L. Engel

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CC: Distribution

DATE: 16 August 1982

REF: HS236-8110

SUBJECT: Flight Vibration Test -

Quick Look

FROM: S. G. Oxley

BLDG. S1

MAIL STA. D306

فيسا أدامات ساهمة المستملا فمثاراته

EXT. 74338

Summary

Vibration of the flight model Thematic Mapper caused mo functional degradation. However, linear variable differential transformer (LVDT) data indicate that LVDT 3 moved 0.8 mils during the Z-axis vibration. Presently scheduled thermal vacuum tests will determine if this is an indication of actual inchworm motion.

Telescope baseplate temperature telemetry failed prior to vibration and the odd preamplifier temperature telemetry was not tested due to a test cable failure. All other telemetry was functional at all times.

Introduction

The flight model Thematic Mapper was vibrated along each of three orthogonal axes on 14 and 15 August 1982. A system readiness test (SRT) was conducted before vibration and after each axis of vibration. This memo summarizes the results of these SRT's.

Relays

Prior to each vibration, the thermal shutdown relay was enabled and the cooler door latch relay was closed; all other relays were open. After each vibration it was verified that no relays had changed state.

Commands

All commands, both normal and redundant, executed properly at all times.

Telemetry

The telescope baseplate temperature telemetry failed prior to vibration. The odd ambient preamplifier temperature channel was open in a test cable and, therefore, not tested. All other telemetry was functional before and after each vibration.

Multiplexer

The multiplexer functioned properly.

Scan Mirror

The scan mirror functioned properly. Time length data are given in Tables 1 and 2. The small changes in midscan nonlinearity, Table 3, are not a problem.

S. G. Oxley to J. L. Engel HS236-8110

16 August 1982 Page 2

Scan Line Corrector

The scan line corrector was functional as indicated by scan line corrector drive current telemetry as observed on a chart recorder.

Shutter

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The calibration shutter functioned properly. Figure 1 shows a typical "before and after" calibration pulse.

Backup Shutter

The backup shutter functioned properly as indicated by phase lock and amplitude lock telemetry.

Calibration Lamps

The internal lamps and the lamp sequencer functioned properly throughout the tests.

Video Channels

All band 1 through band 4 video channels were operable before and after vibration.

Cooler Door

The cooler door drive was functional in all respects before and after vibration.

LVDT

The LVDT's functioned at all times. However, as shown in Table 4, telemetry indicates that LVDT 3 moved 0.8 mils during the 2-axis vibration. Additional, presently scheduled, tests will show if this represents actual inchworm motion.

Systems Engineering

/lbg

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-			19:32	2	132.9	-132,7	60742,8	176.8	-176.6	60742.8
					<i>σ</i> =3.5	0=4.6	o=7.9	σ=3.9	0-:4,2	o=7.8
	HAC	13AUG.	2/07	1	129.4	-129.5	60743.0	182.8	-182.6	60742.8
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١		!	!		J-3.2	o=-4,2	J=7,2	0=4.1	0-5.0	o= 8,9
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SANTA BARBARA RESEARCH CENTER A Subsidiery of Hughes Aircraft Company

INTERNAL MEMORANDUM

TO F. Phillips

CC. Distribution

DATE: 25 August 1982

REF: HS 236-8119

SUBJECT. TM Fl Vibration and

Acoustic Test Results

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FROM: R. A. Amador

BLDG. B12 MAIL STAL 28

EXT. 6251

- References: 1. TP32015-623, TM Acoustic Test Procedure, 17 May 1982
 - 2. TP32035-609, TM Vibration Test Procedure, 30 June 1982
 - 3. HS236-2154, TM Program, Revisions to Specification GSFC 400.8-D-201, 9 June 1981
 - 4. TM Waiver W-171, August 12, 1982

Summary

The fl Thematic Mapper was exposed to flight acceptance level acoustic noise at TRW Systems on 18 August 1982 and flight acceptance level sine wibration on 13 August through 15 August 1982 at HAC/ES. The results of System Readiness lests (SRTs) conducted at the conclusion of the acoustic test and at the conclusion of each axis of vibration indicated that the measured system performance parameters remained unchanged from the time the system left SBRC. All of the measured acceleration responses were equal to or less than what had been predicted by analysis and linear scaling of protoflight model test results. The Fi TM is structurally sound in all respects and suitable for spacecraft integration from a mechanical standpoint. This report documents the results of both the acoustic and sine vibration testing, the procedures for which are References 1 and 2, respectively.

Acoustic Test Discussion

The first step performed as part of the acoustic test procedure was a nitrogen gas purge with an overall sound pressure level of 122dB. The gas purge provided data points from which extrapolations to flight level acoustic responses were made. The only data recorded in the gas purge were RMS voltages within a 10 khz bandwidth which were converted to g RMS levels. The variation in 3σ acceleration response as a function of applied sound pressure level for accelerometer 4x located on the cooler Joor assembly is shown in Figure 1. The location of accelerometer No. 4 showed the highest dynamic response of all response locations in the full level acoustic test.

The fifteen response power spectral densities and g RMS levels recoraed on the F1 YM during the 138 dB overall sound pressure exposure (-6 aB down from flight level) were such that the structural integrity of the TM could be predicted to not be adversely affected in the full

25 August 1982

F. Phillips from A. Amador
TM Fl Vibration and Acoustic
Test Results
Page 2

level 144 dB overall sound pressure level run. The results of the 144 dB full level run enveloped the linear extrapolations made from the -6 dB results. Specifically, the structural damping factors in the 144 dB responses were greater than what had been predicted by linear extrapolation from the -6 dB results such that the acceleration responses in the full level run were lower then the predictions.

The maximum response measured in the 144 dB overall full level run was 34.5 g 3σ peak at accelerometer No. 4x located on the cocler door assembly adjacent to the door hinge on the foot side of the TM. Figures 2 and 3 illustrate the location of the five triax accelerometers. During EM/STM cooler door/shroud penalty testing, the door response was driven to 82 g 3σ peak and the magnetic latches provided enough holding force such that the door did not open. The 34.5 g 3σ peak on the door assembly discussed above corresponds approximately to 46.5 g 3σ response of the door itself which indicates a minimum margin on the door not opening of 70%.

The Appendix contains all of the recorded -6 dB power spectral density responses as was the preliminary full level responses of all accelerometers. The final PSDs will be included in a separate document from TRW Systems to be released once the data is available and verified.

As part of the preparation for the acoustic test, deflection measurements were taken of the TM shipping container when loaded with 780 lbs (TM plus fixture). The purpose of the measurements was to assure a minimum natural frequency less than or equal to 50 hz for the TM . moving as a rigid body on the shipping container. These measurements indicated a 5.6 hz natural frequency which was well below the maximum allowable. See Figure 4 for the acoustic test setup.

Vibration Testing Discussion

The sequence of vibration testing was y, z, and x axis and is defined in Table 1. Table 2 lists the locations of the response accelerometers. Four separate tests were rul per axis: 1) 1/4 g RMS random burst 5-500 hz; 2) 1/4 g peak sine sweep 5-500 hz; 3) flight sine as defined in Table 3; and 4) 1/4 g RMS random burst 5-500 hz. The amplifications at the frequency of the maximum response measured for each of the in-axis accelerometers during the flight sine tests are summarized in Table 4. The measured responses are well below design levels. The lowest modes of vibration are described in Table 5 for each axis.

R. A. Amador

Attachments

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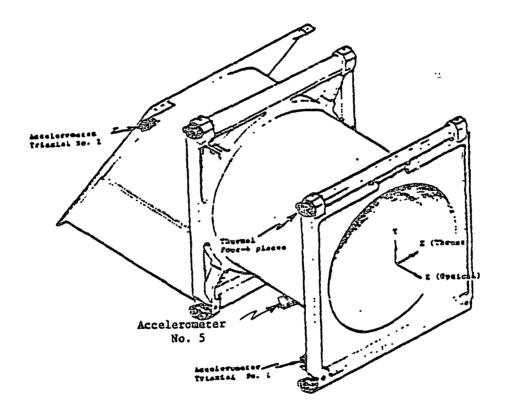
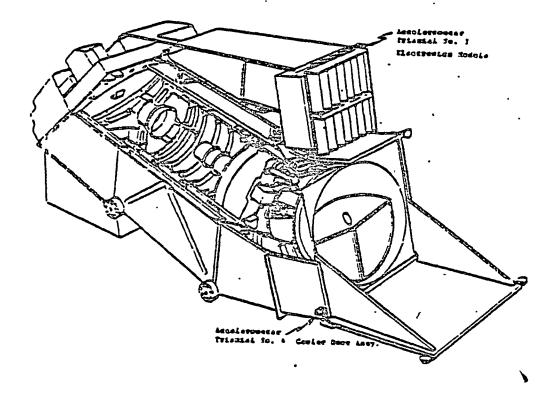


FIGURE 2. ACCELEROMETERS #1, #2, and #5 LOCATIONS



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FIGURE 3. ACCELEROMETERS #3, #4 LOCATIONS

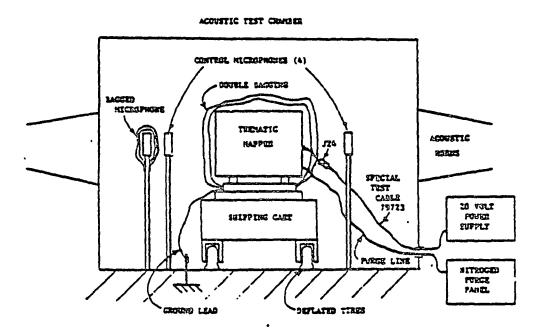


FIGURE 4. TM ACOUSTIC TEST SETUP

TABLE 1

TEST SEQUENCE

TEST NUMBER		DESCRIPTION
110	Y Axis,	random burst, 1/4 g RMS 5-500 hz 60 sec.
3110	Y Axis,	low level sine, 1/4 g peak 5-500 hz
3130	Y Axis,	flight sine (See Table 3)
130	Y Axis,	random burst, 1/4 g RMS 5-500 hz
210	Z Axis,	random burst, 1/4 g RMS 5-500 hz
3210	Z Axis,	low level sine, 1/4 g peak 5-500 hz
3230	Z Axis,	flight sine (See Table 3)
230	Z Axis,	random burst, 1/4 g RMS 5-500 hz
010	X Axis,	Random burst, 1/4 g RMS 5-500 hz
3010	X Axis,	low level sine, 1/4 g peak 5-500 hz
3030	X Axis,	flight sine (See Table 3)
030	X Axis,	random burst, 1/4 g RMS 5-500 hz

TABLE 2

ACCELEROMETER LOCATIONS

LOCATION NO.	AXIS	LOCATION
1	XYZ	Optical Assy. main frame bulkhead
2	XYZ	SMA main frame bulkhead
3	XYZ	Electronics module
4	XYZ	Cooler Shroud/Door Imterface
5	XYZ	ADS Thermal Mass

TABLE 3

FLIGHT SINE VIBRATION

AXIS	FREQU	ENC	Y (hz)	LEVEL	(g	ph)
x	5	- 1	1.1	0.64	in	D.A.
(Thrust)	11.1	- 5	0	4.0		
	50	- 1	.00	2.4		
Y and Z	5	- 9	. 3	0.64	in	D.A.
	9.3	- 3	5	2.8		
	35	- 1	.00	1.2		
	Sweep Rate	= 4	oct/min			

NOTE: See References 3 and 4.

TABLE 4

Maximum Amplifications at Frequencies ≤ 100 Hz

Axis	Frequency(hz)	H(jw) G(jw)	Location
x	92	4.0	4 x
y	85	8.5	3 y
z	65	7.6	3 z

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TABLE 5

LOWEST MODES OF VIBRATION IN EACH AXIS < 100 HZ

AXIS	FREQUENCY (HZ)	MODE DESCRIPTION
(Thrust) x	16; 26	Two nonlinear shaker modes: TM, fixture & armature, off of shaker flexures
y	80 - 85	Nonlinear rocking mode: TM as a rigid body off of thermal feet flexibility
z	65 - 68 _.	Nonlinear rocking mode: TM as a rigid body of thermal feet flexibility

APPENDIX

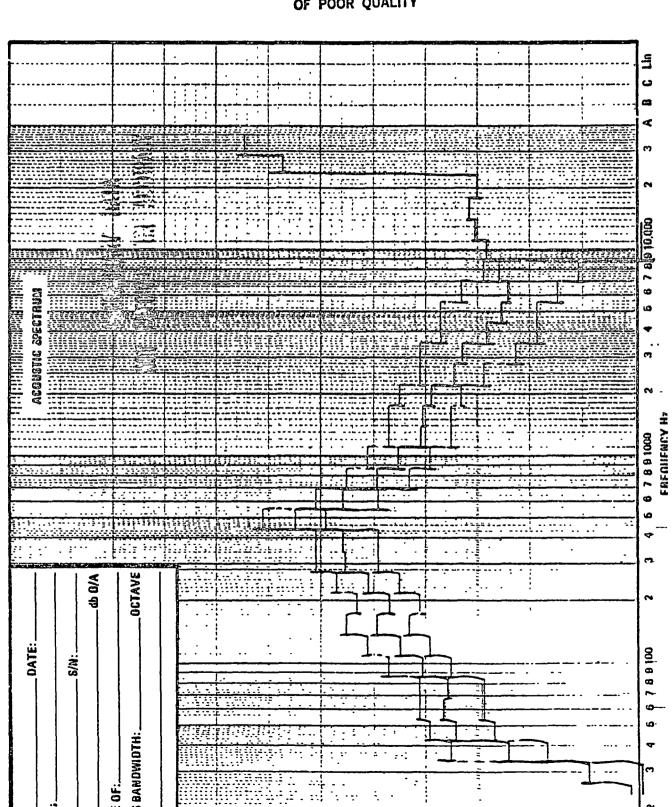
- o Acoustic Responses
- o Vibration Data All Axes

ACOUSTIC NOISE TEST DURATION 1 MINUTE

	CENTER FREG. (Hz) CNE-THIRD CCTAVE CCTAVE		FLIGHT/ ACCEPTANCE UNE-THIRD UCTAVE OCTAVE		PROTOFLIGHT/ QUALIFICATION ONE-THIRD OCTAVE OCTAVE		TEST TOLERANCE dB	
•	25 32 40	32	119 120 121	125	122 123 124	128	÷3,	-6
D	50 43 80	63	123 124 124	128	126 127 127	131	+3,	-3
-	100 125 160	123	127 129 131	134	130 132 134	137	÷3,	-3
	200 250 315	290	130 132 134	137	133 133 137	140	+3,	-3
Ð,	400 500 630	300	134 139 134	141.	137 142 137	144	+3,	- 3
	800 1000 1230	1000	131 129 127	134	134 132 130	137	+3,	-3
•	1600 2000 2500	2000	127 126 124	131	130 129 127	134	+3,	-3
•	3150 4000 5000	4000	124 122 122	127	127 129 129	130	+3,	-6
	5300 8000 10,000	8000	120 118 118	124	123 121 121	127	+3,	-6
Ð	OVERALL		144		147		+1,	-1

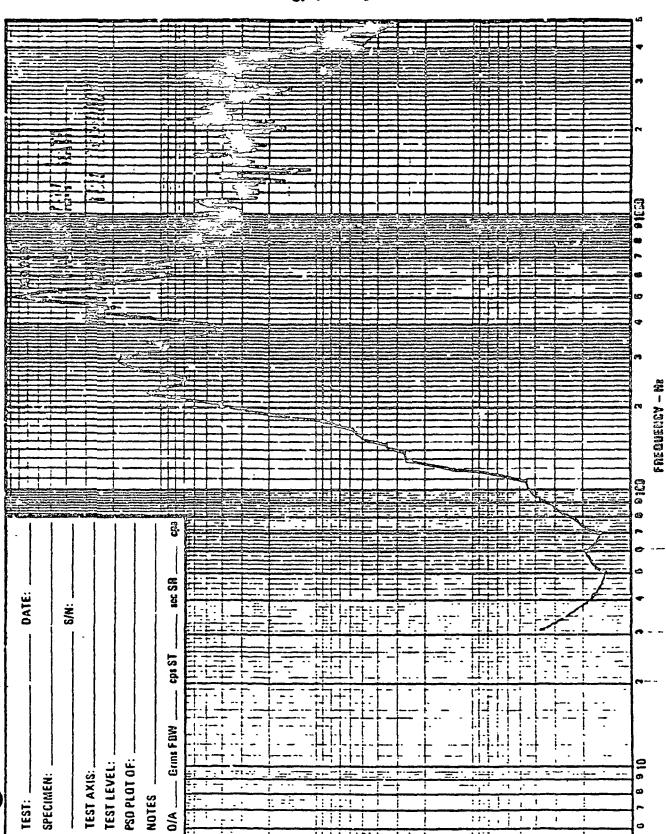
NOTE: Flight Acceptance Levels Applied to F1 Hardware Sound Pressure Level (d3 Ref: 20 Micro N/M2)

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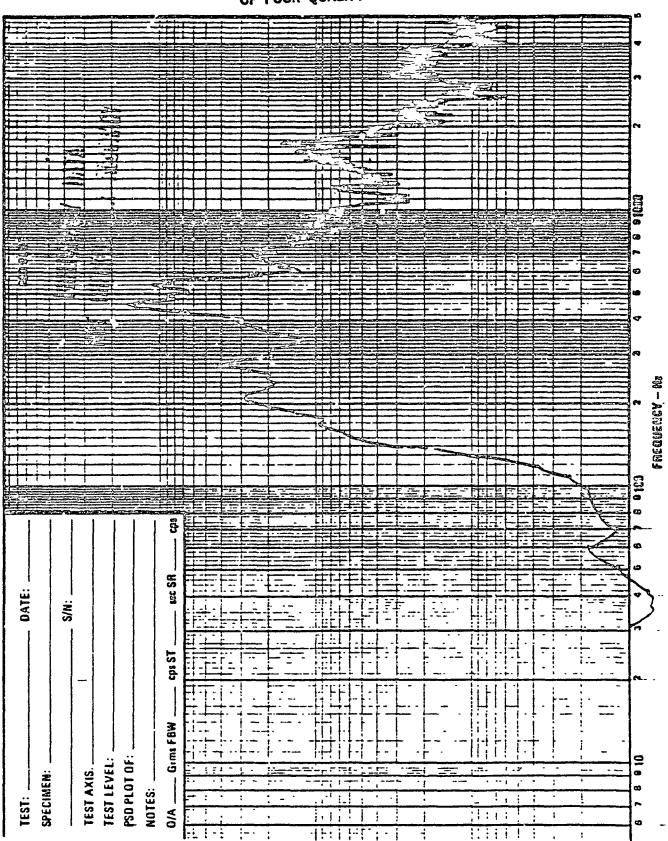


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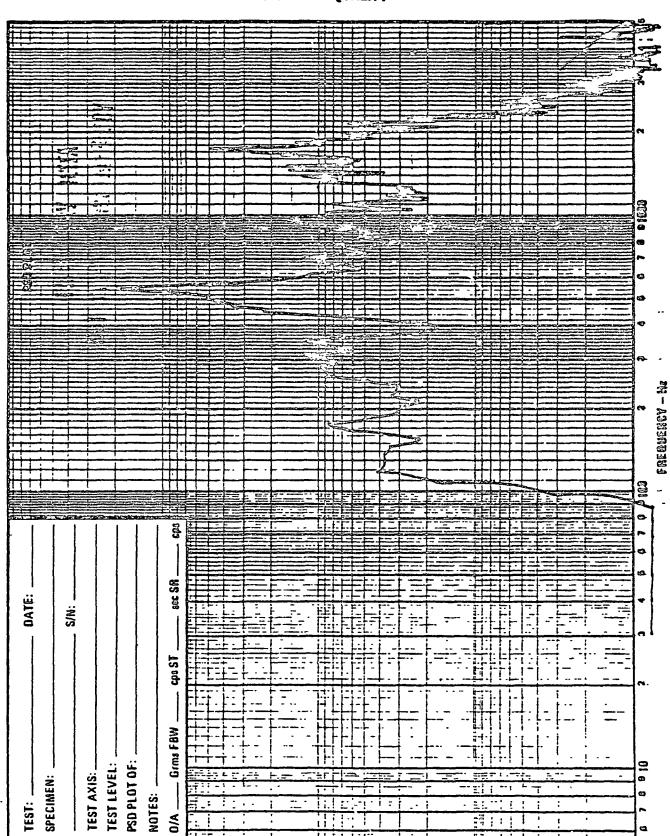
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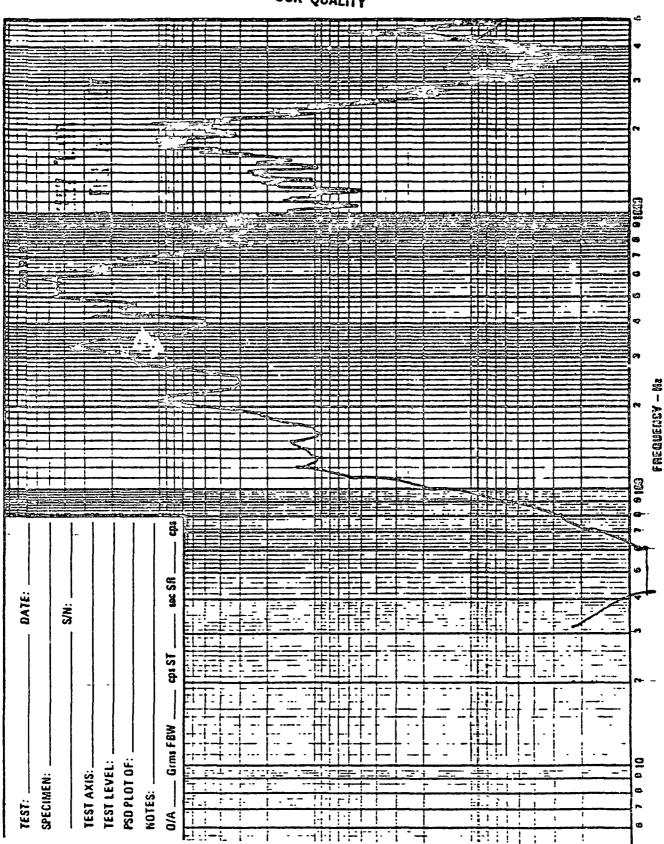


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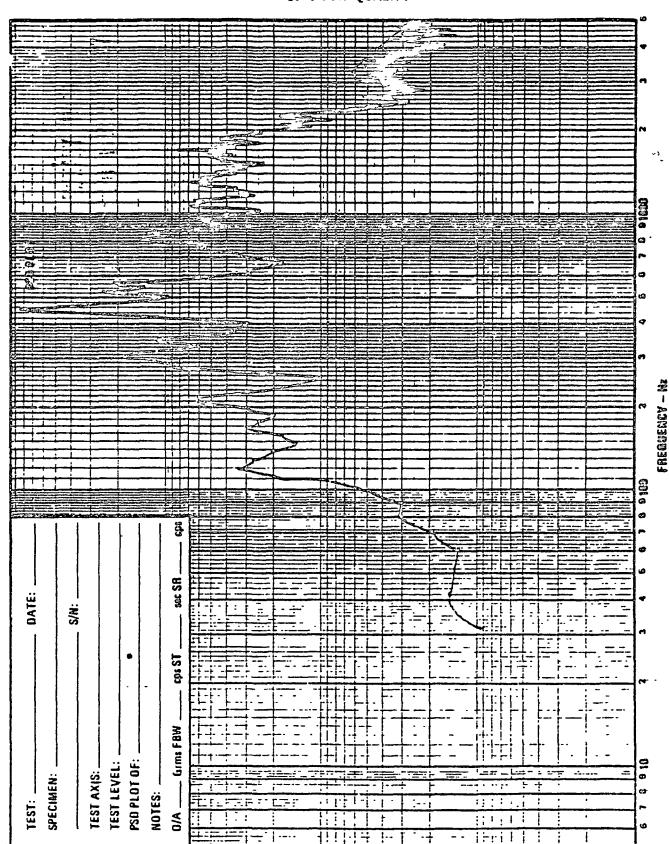
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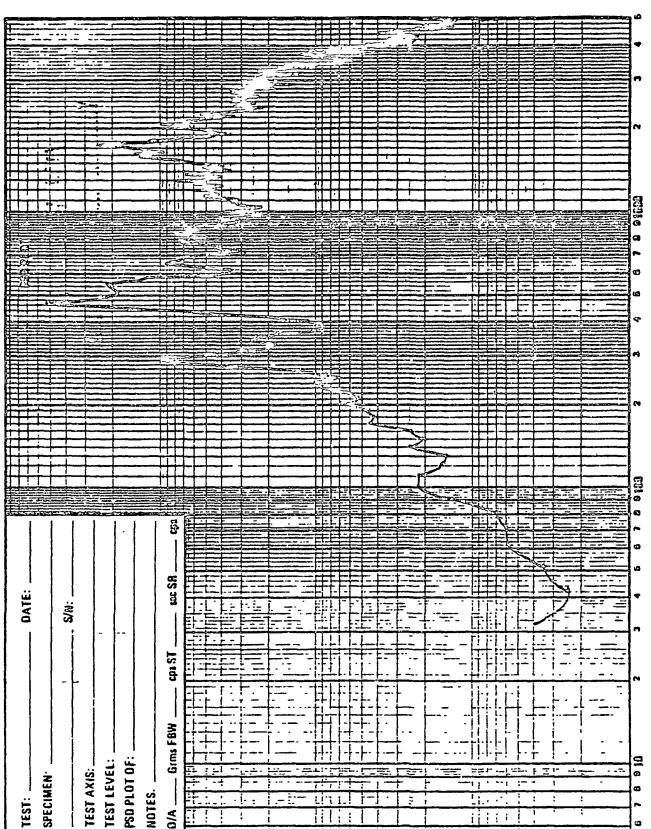
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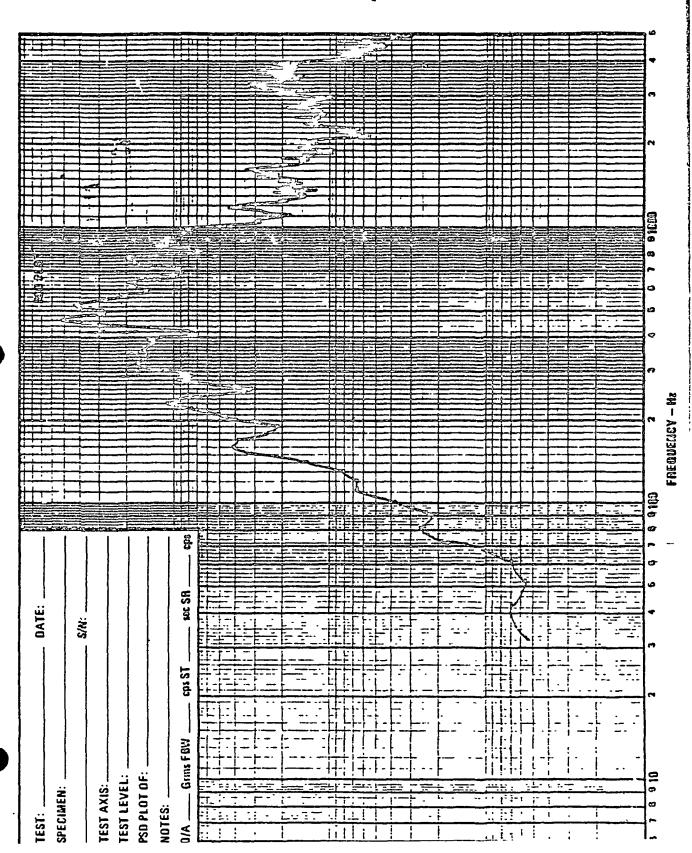
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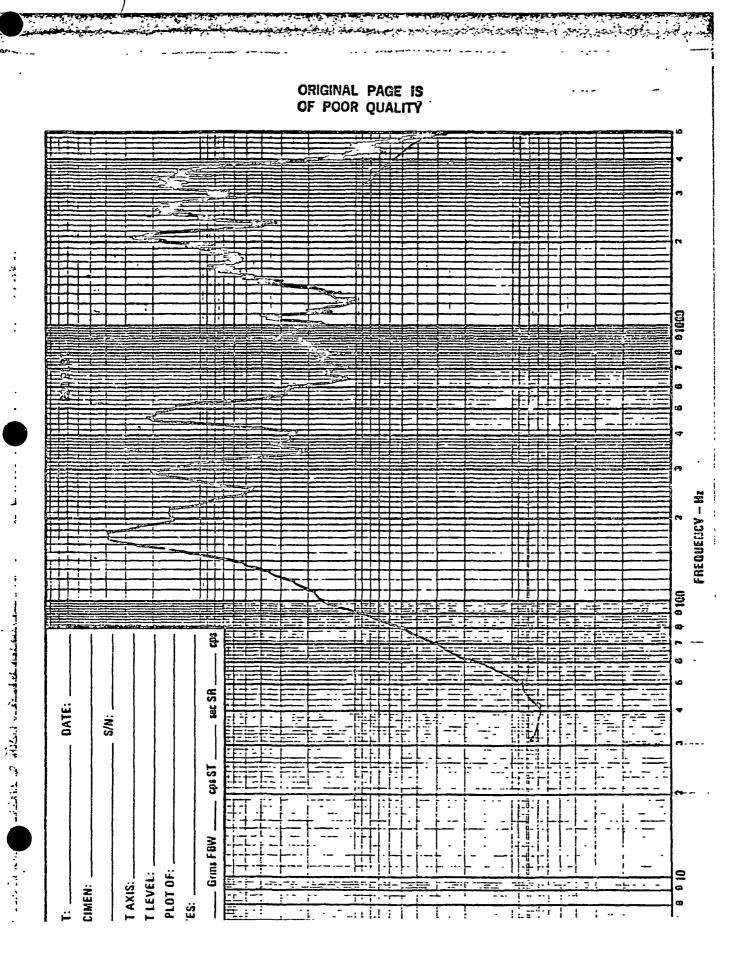
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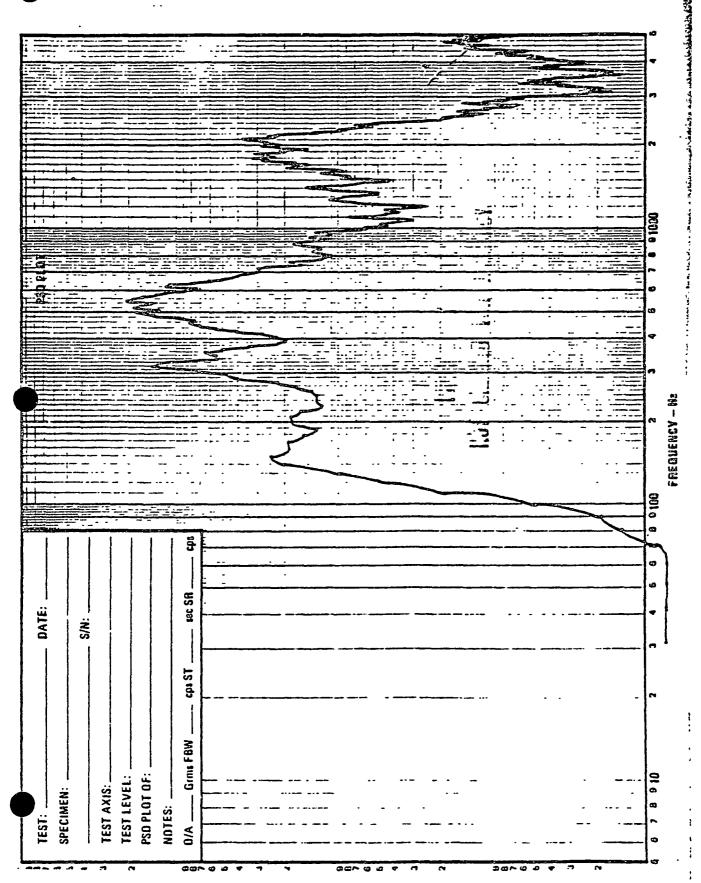
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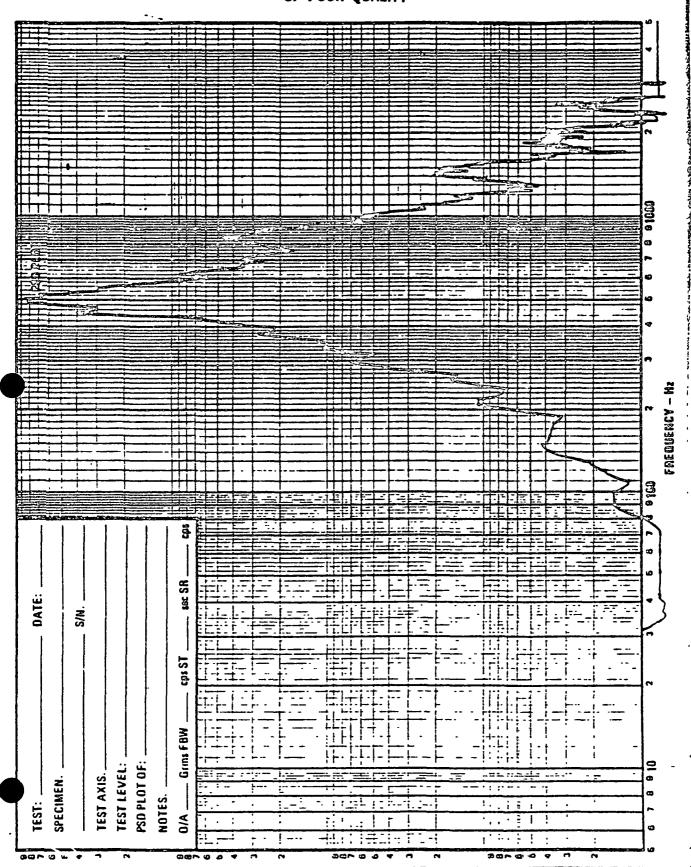
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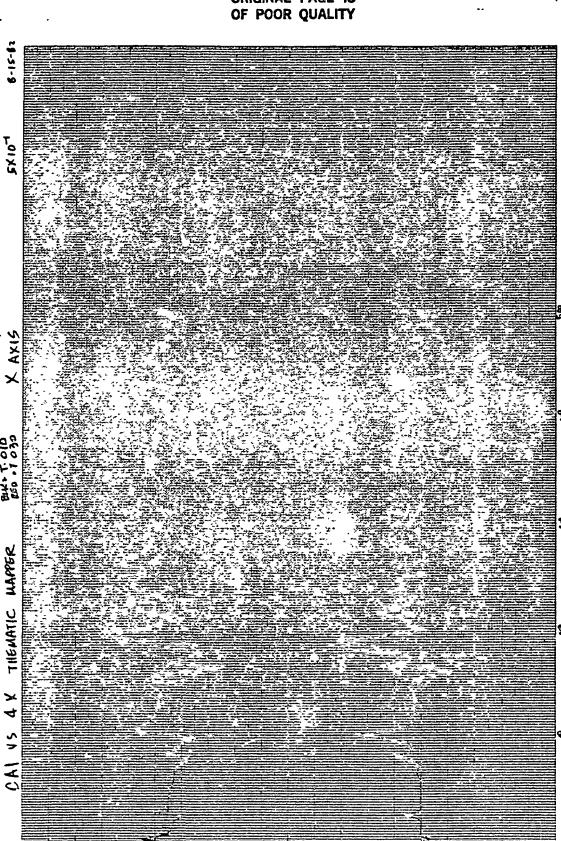
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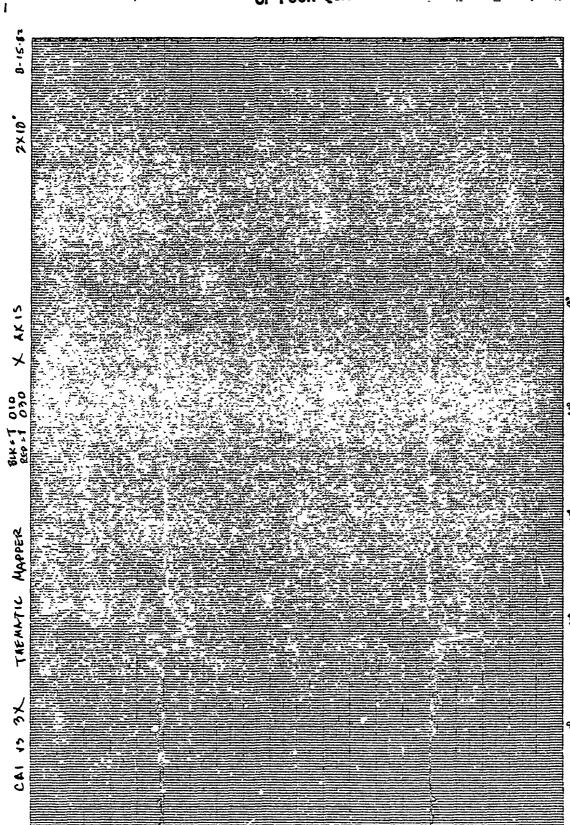
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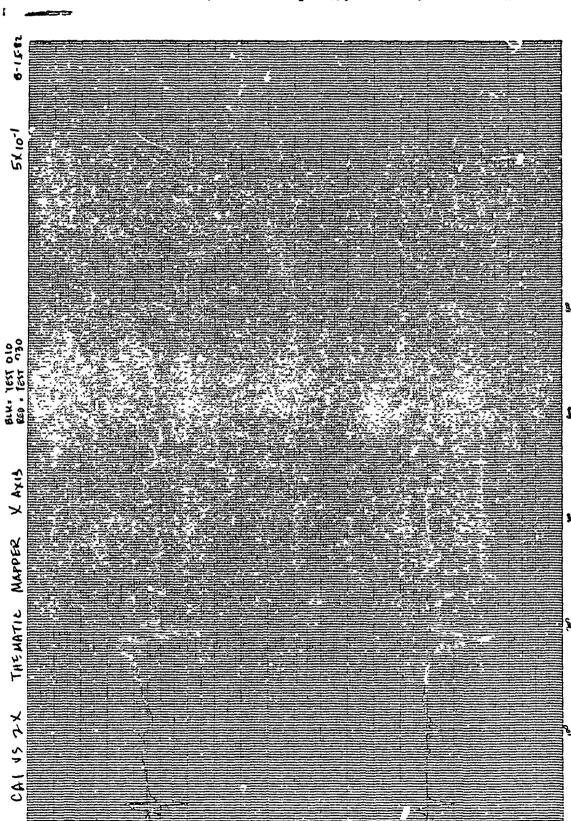
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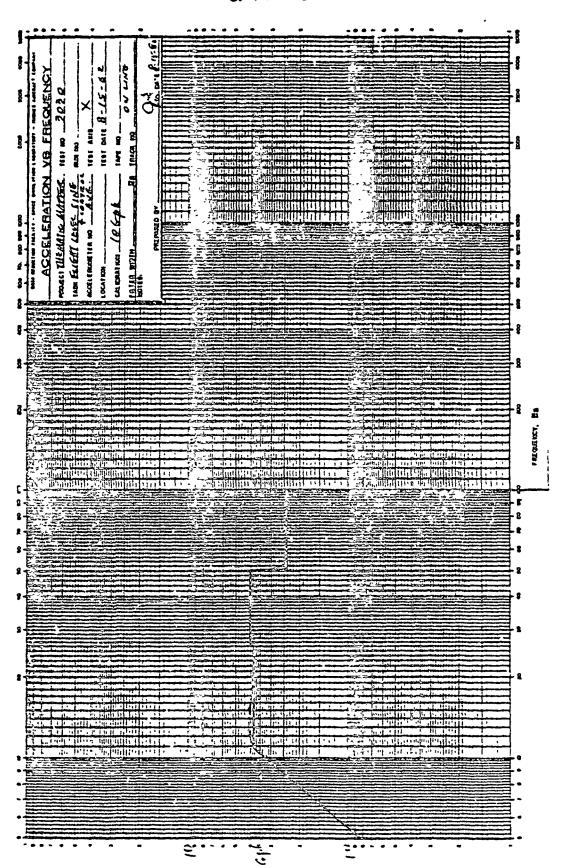
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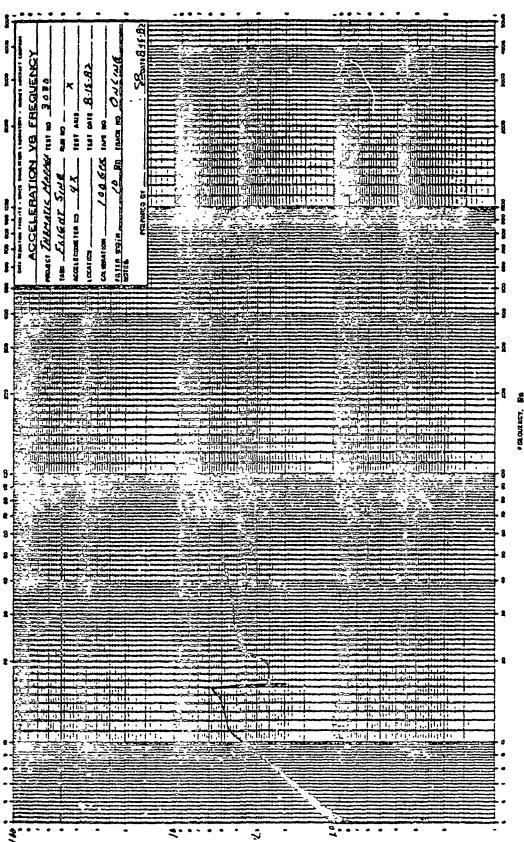


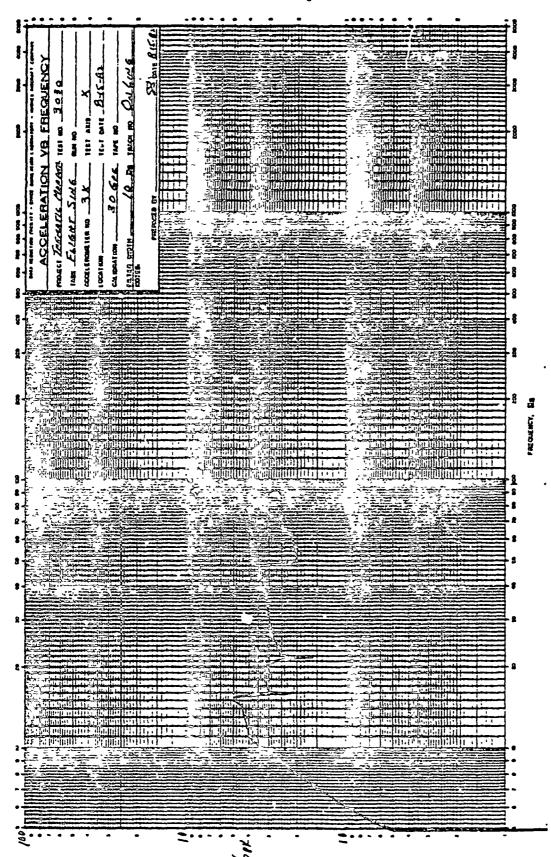
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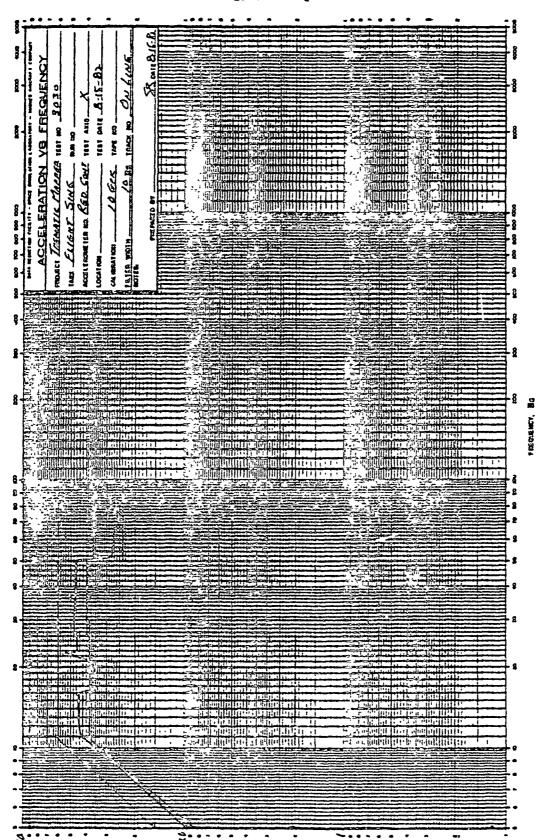


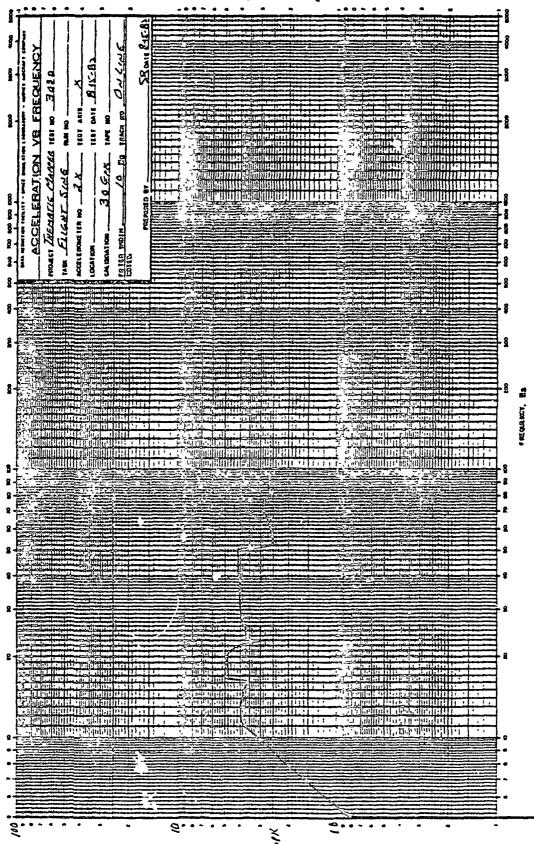
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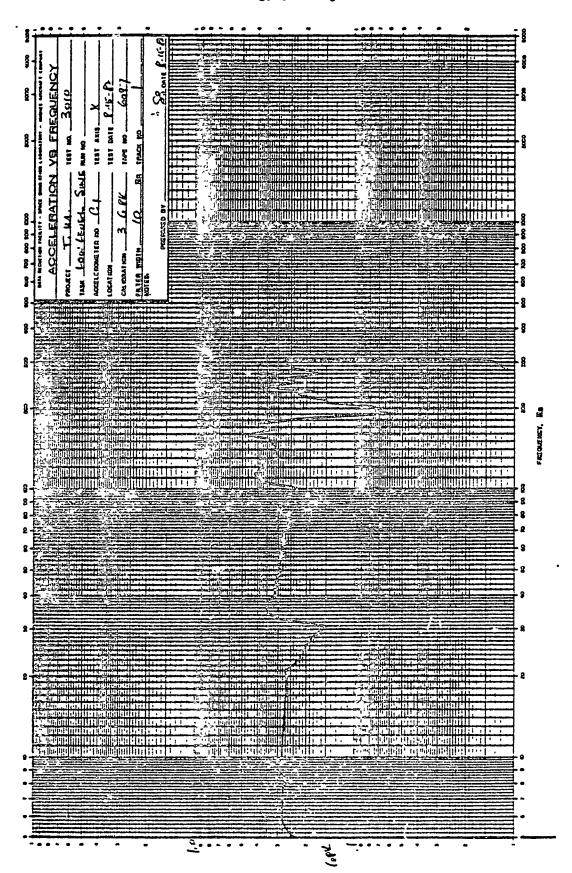


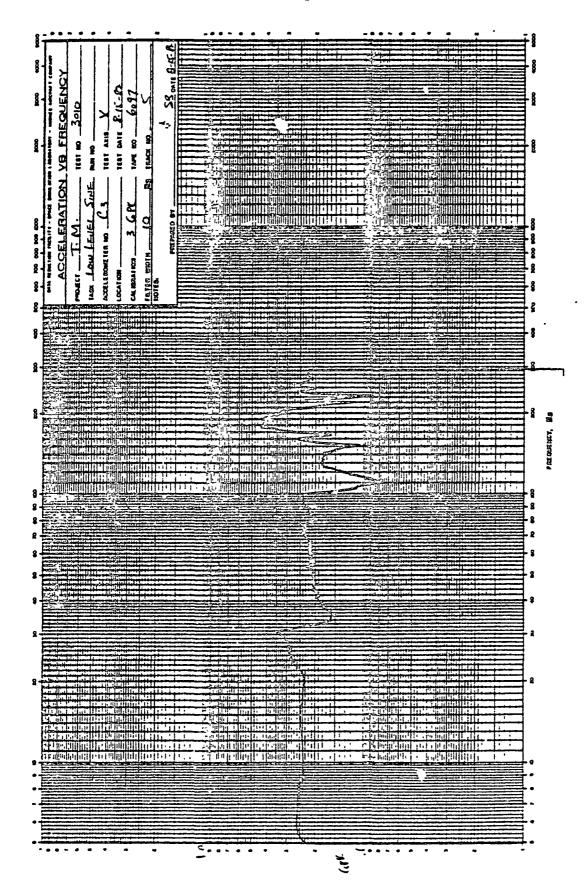




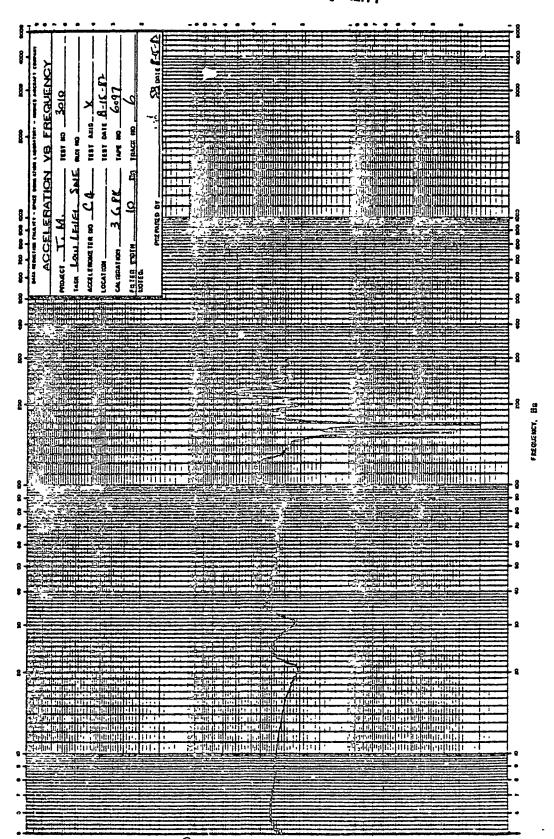


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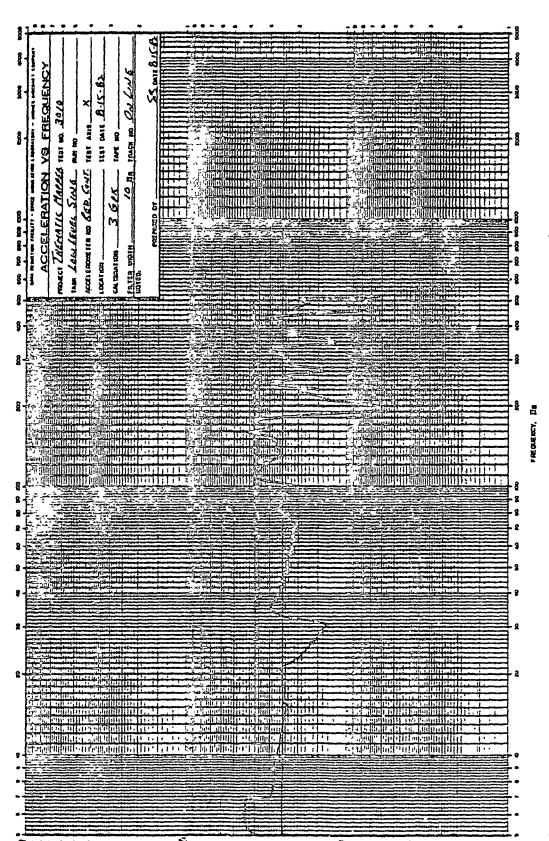




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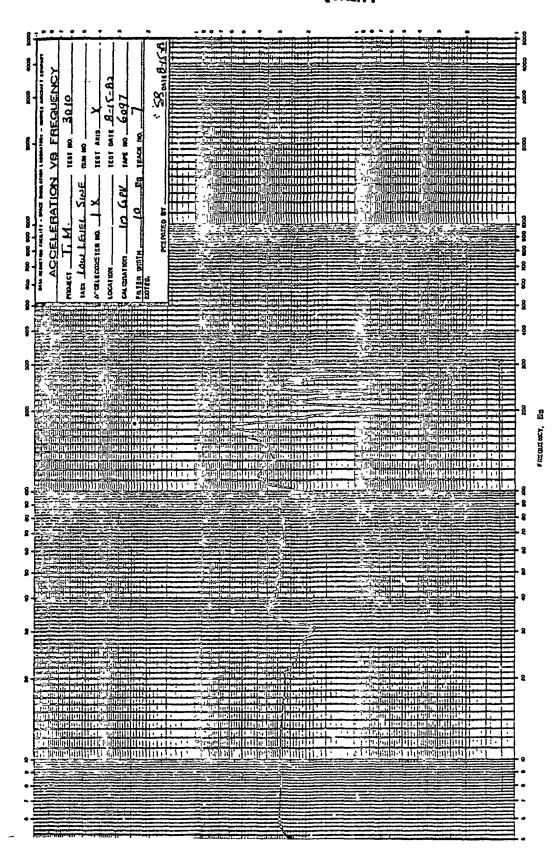
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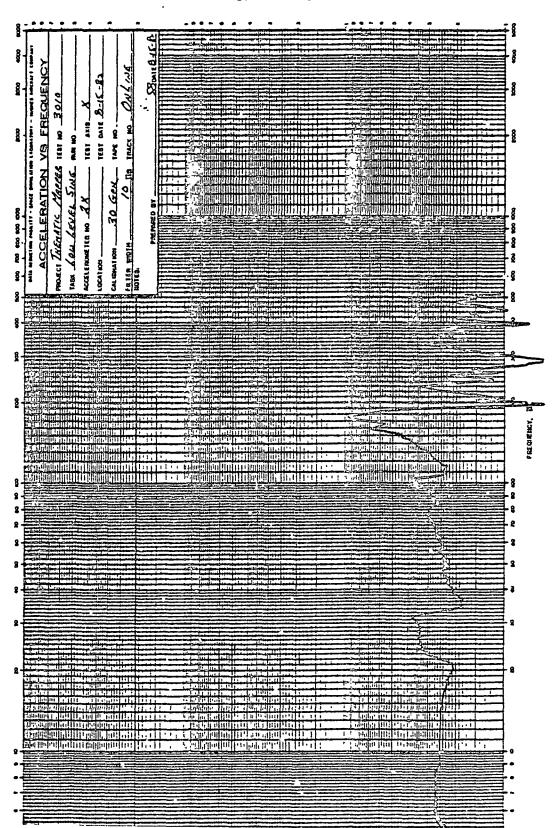


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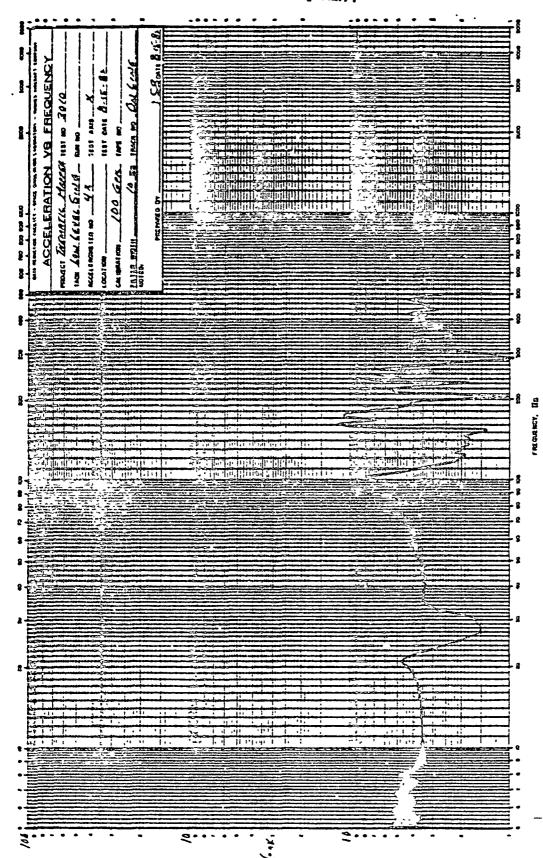
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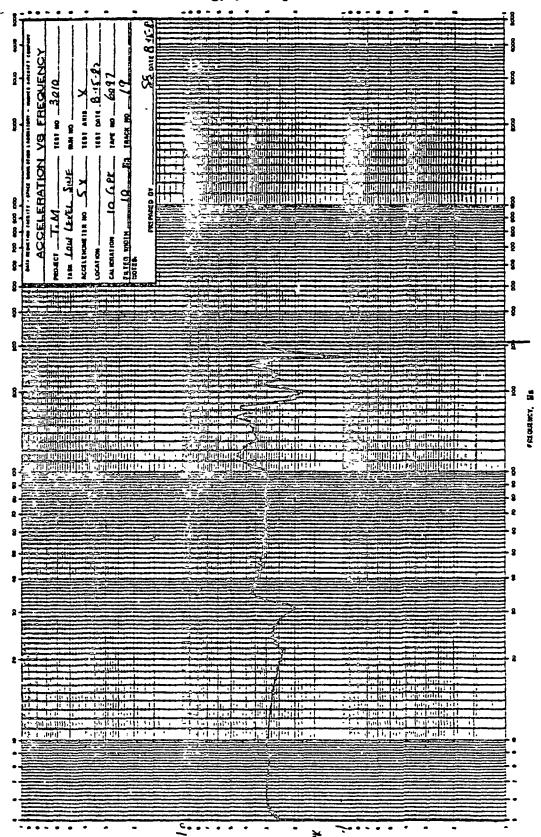




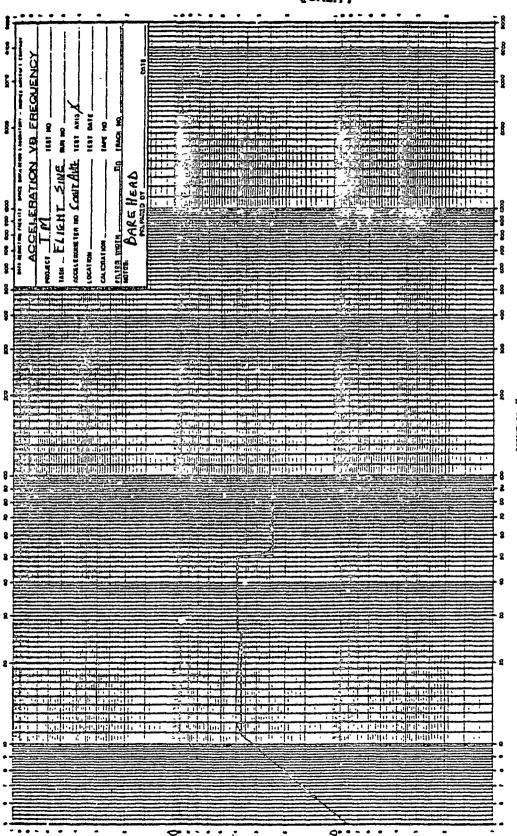
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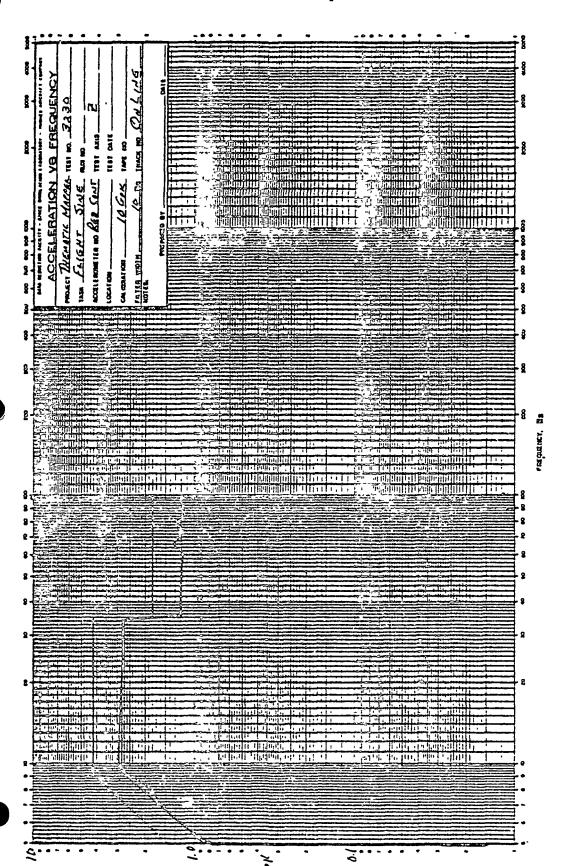
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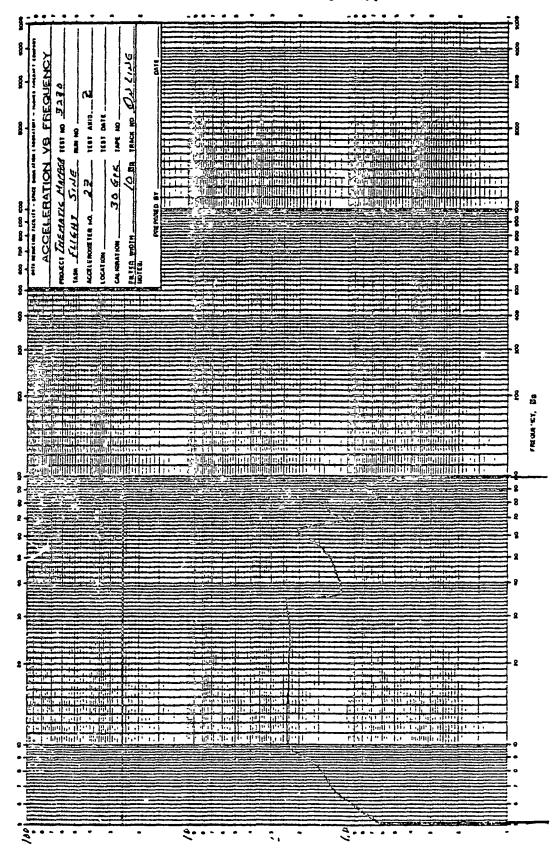


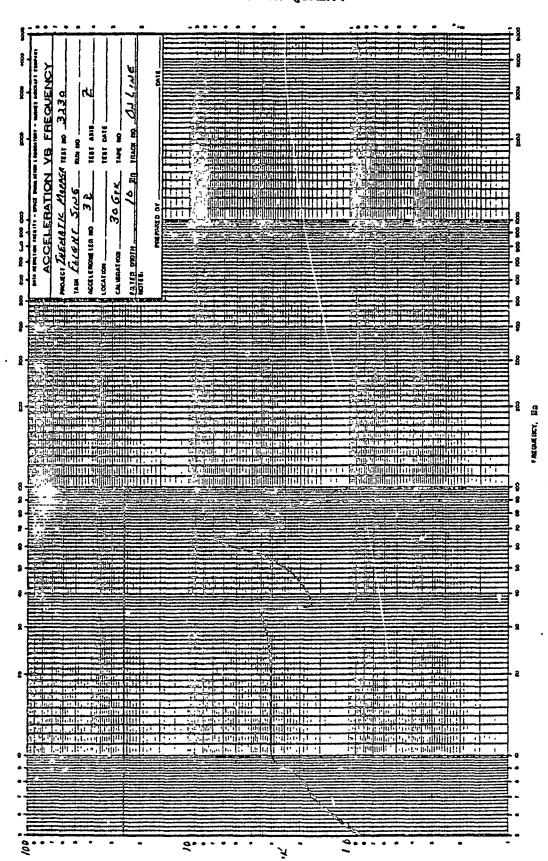


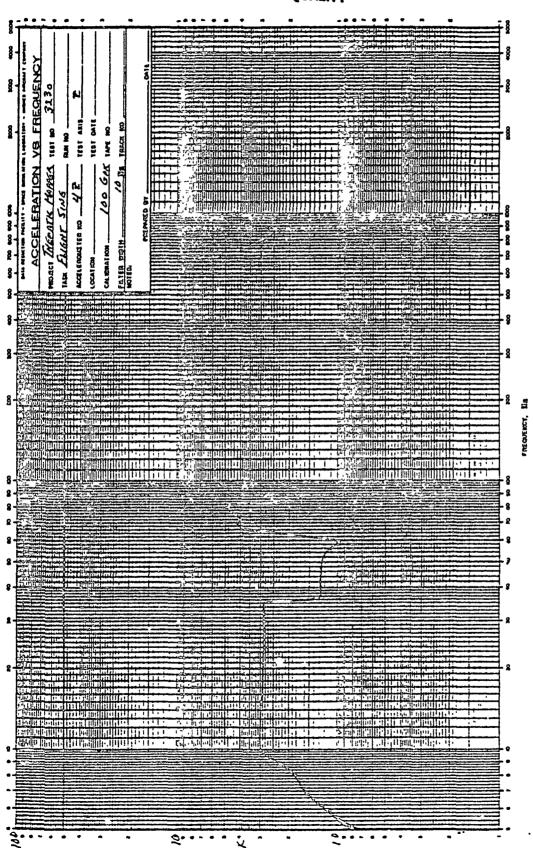
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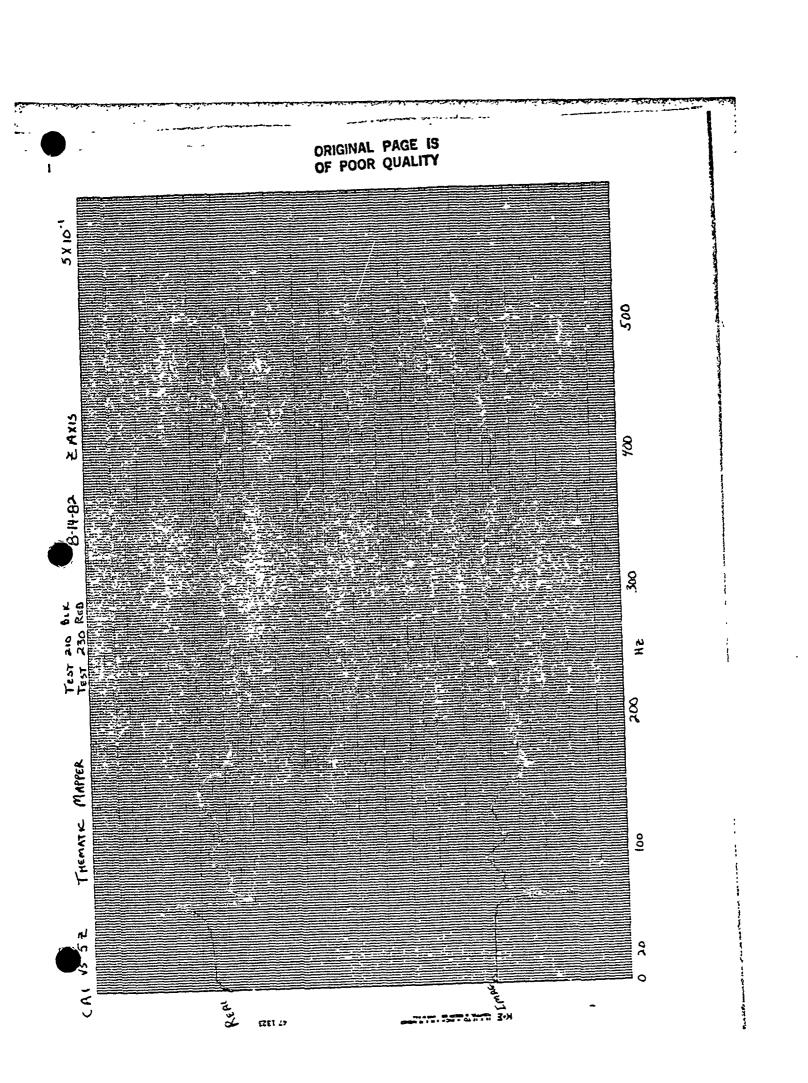


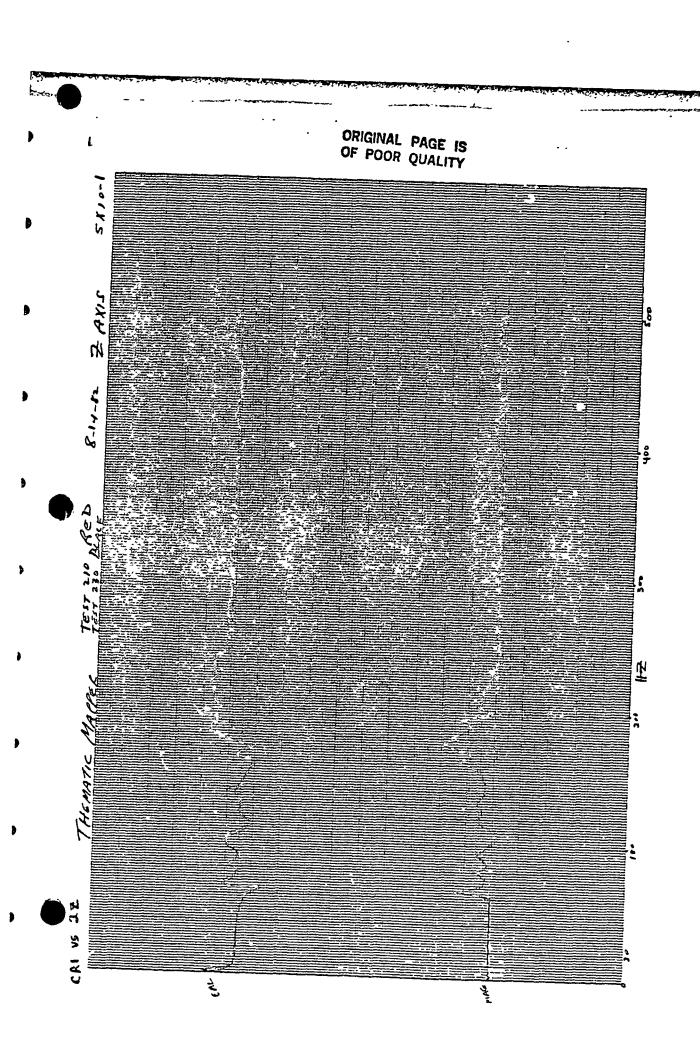


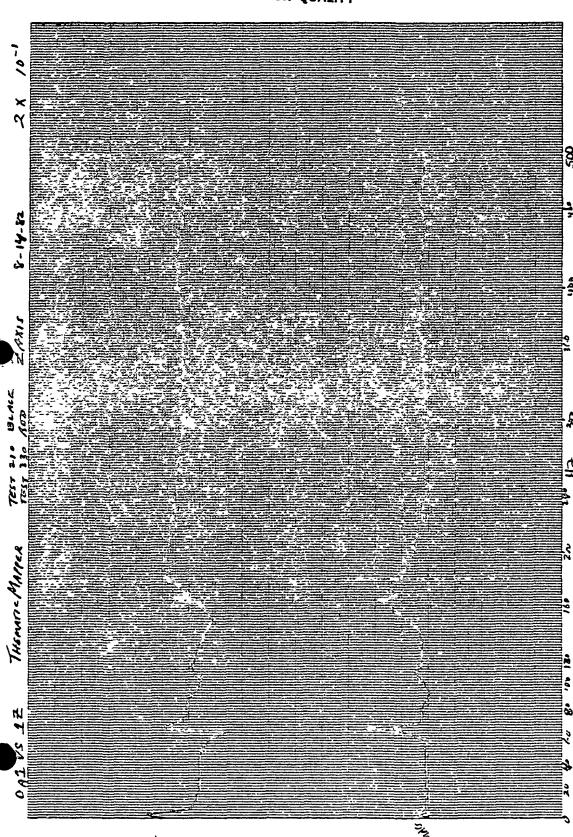


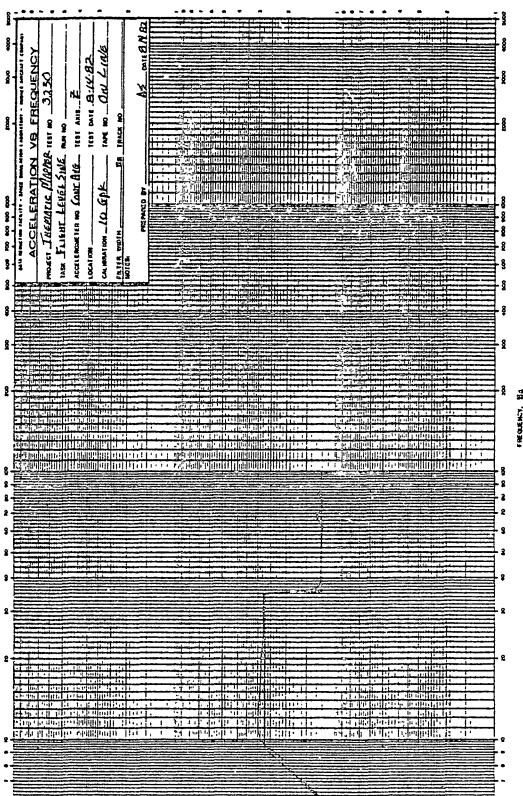








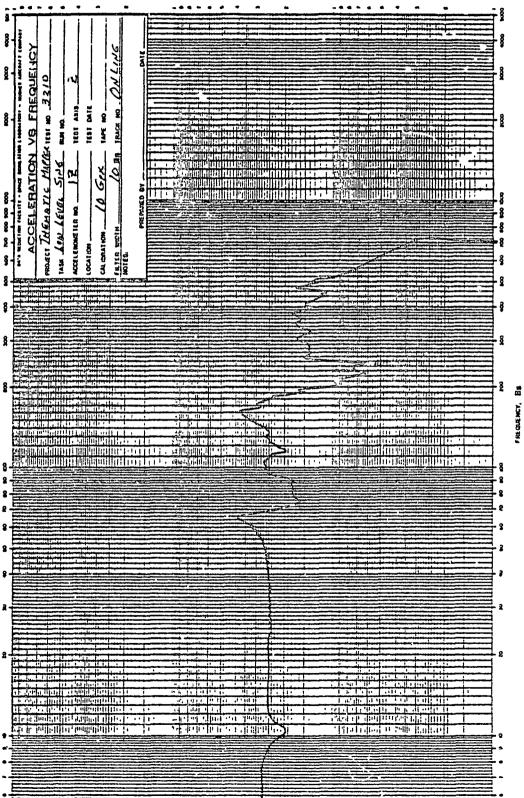


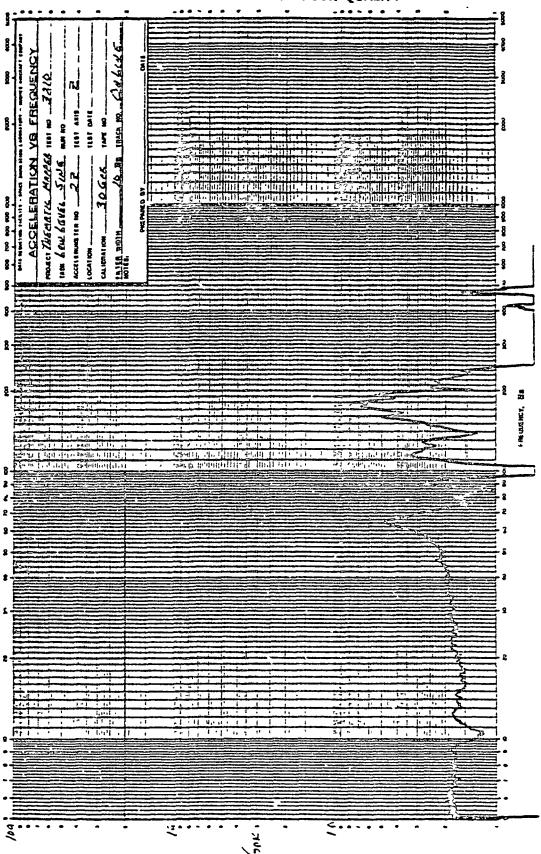


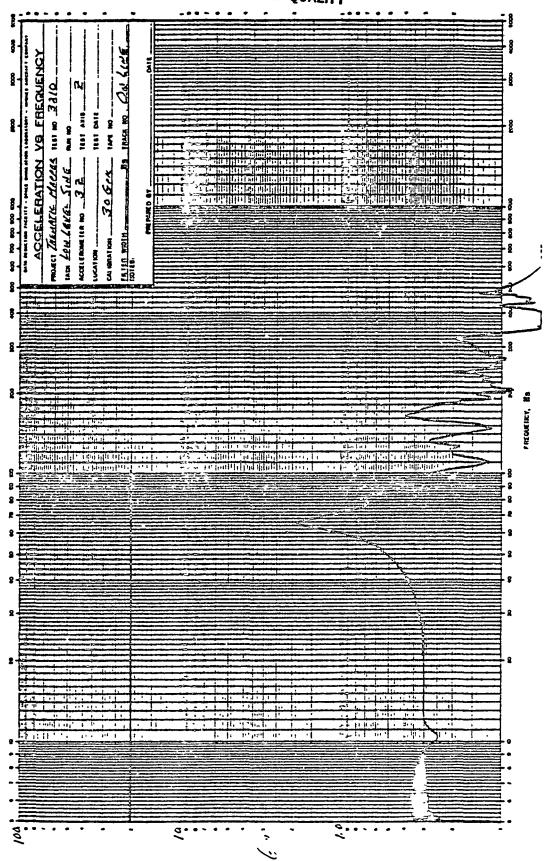
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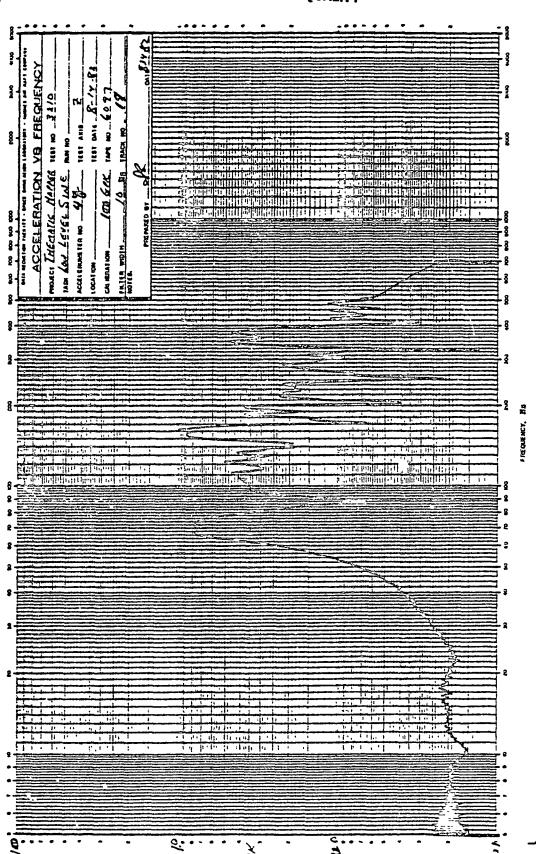
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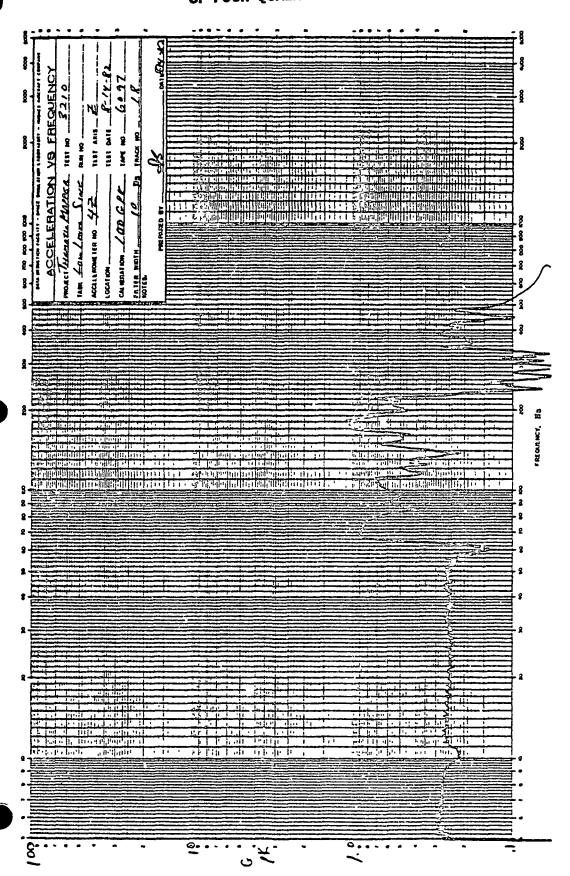
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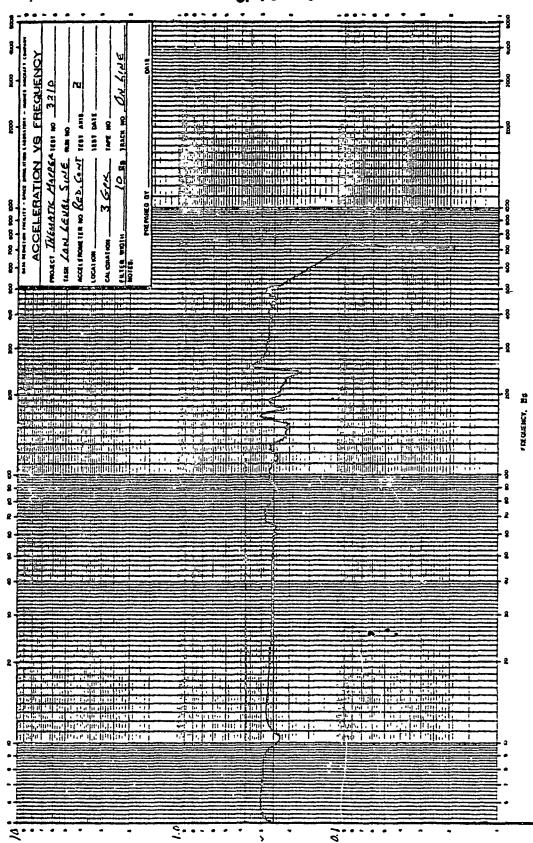




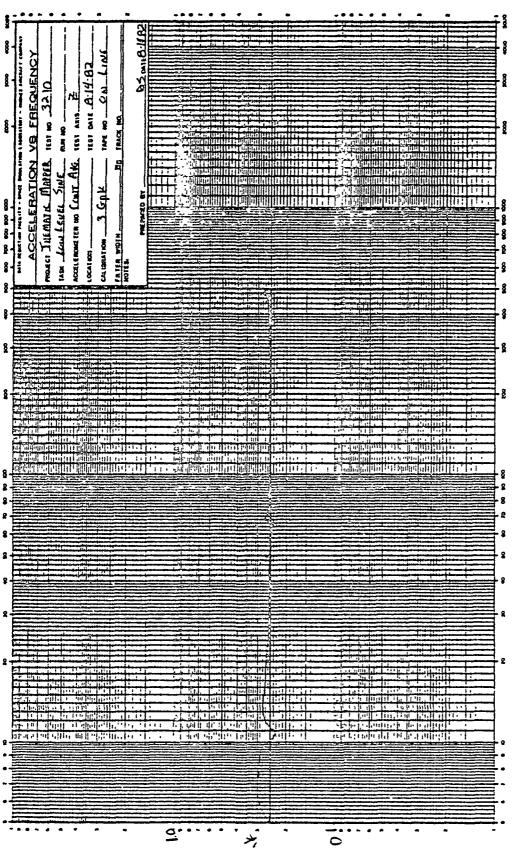


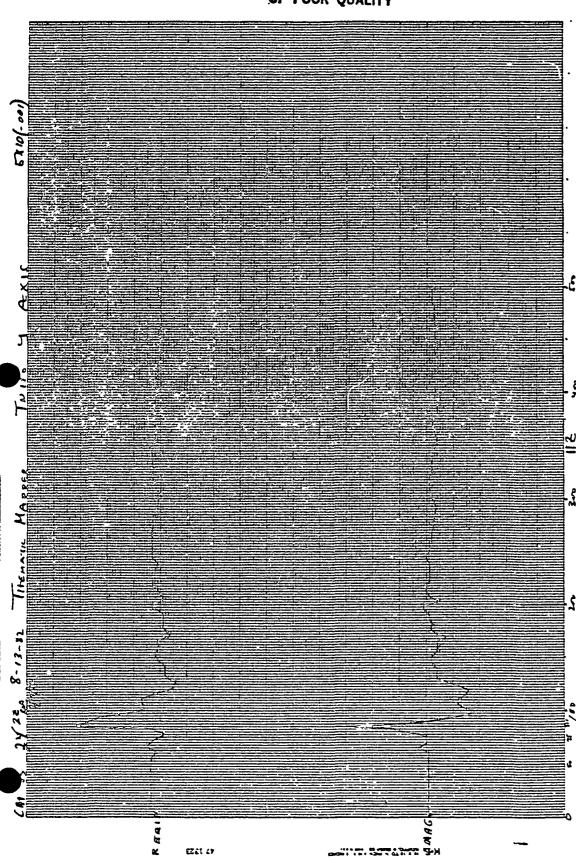






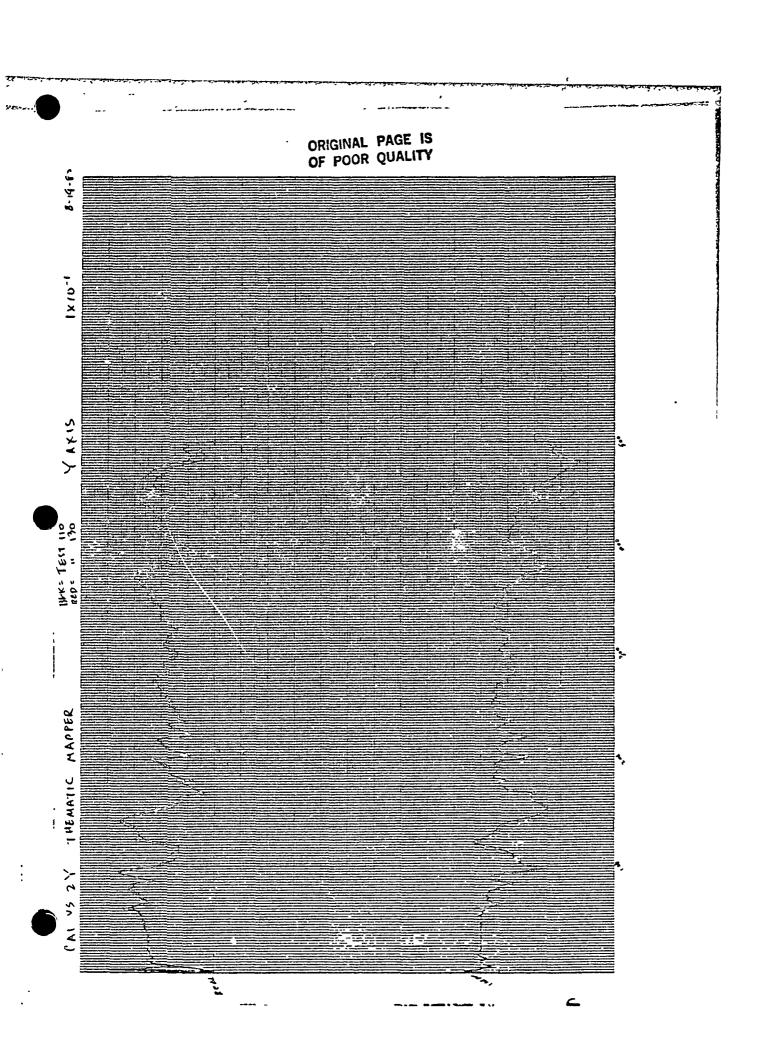
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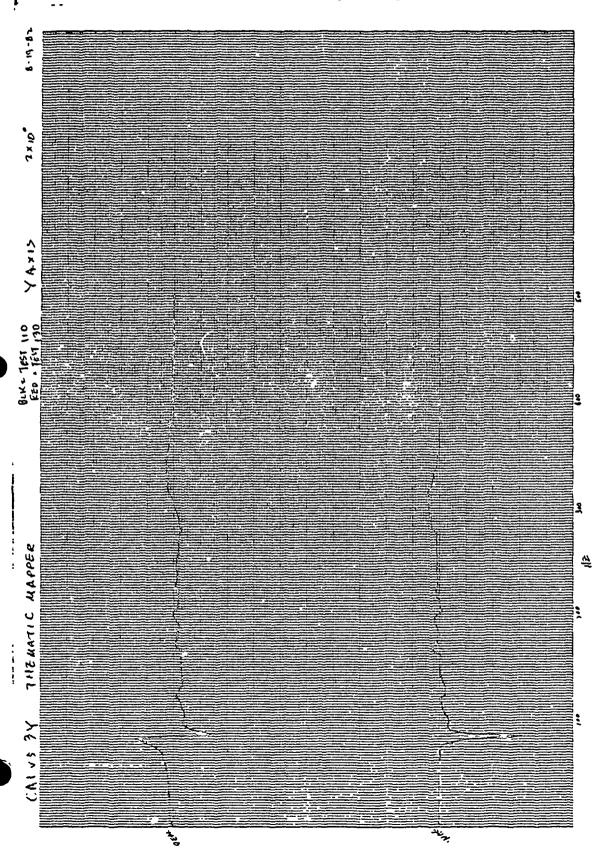




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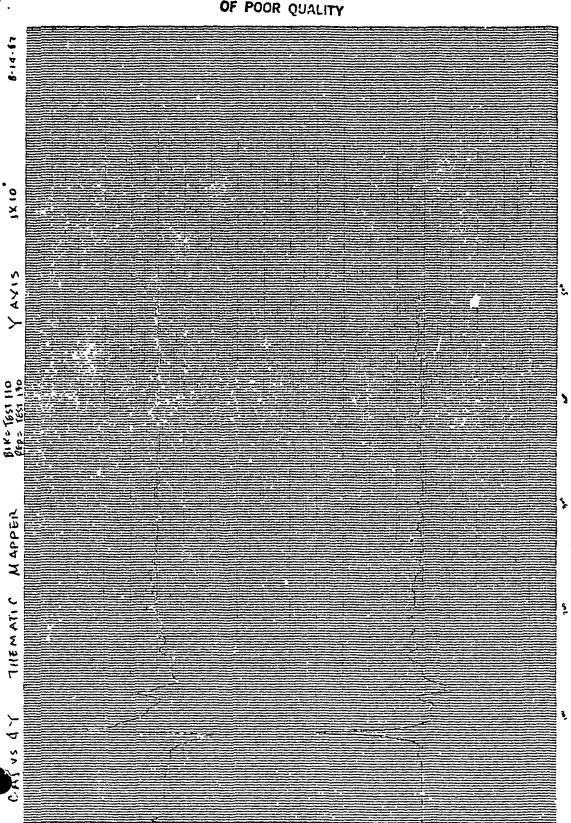
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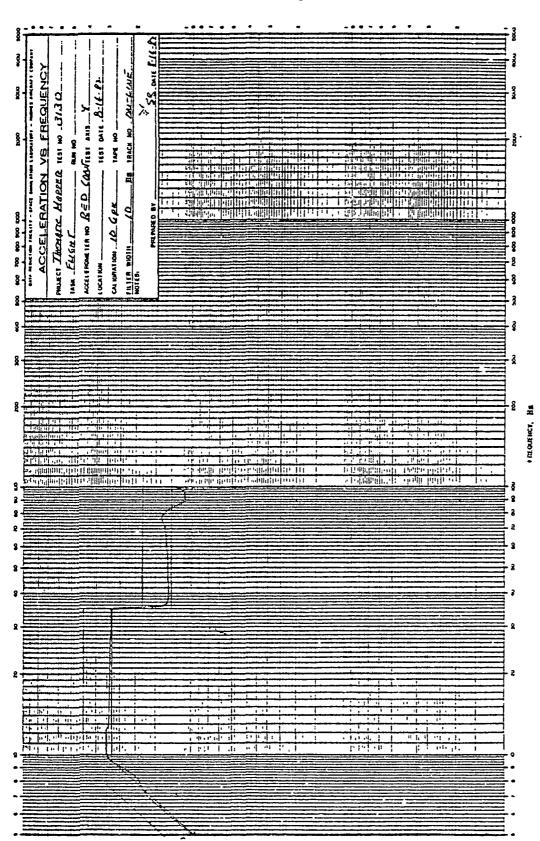




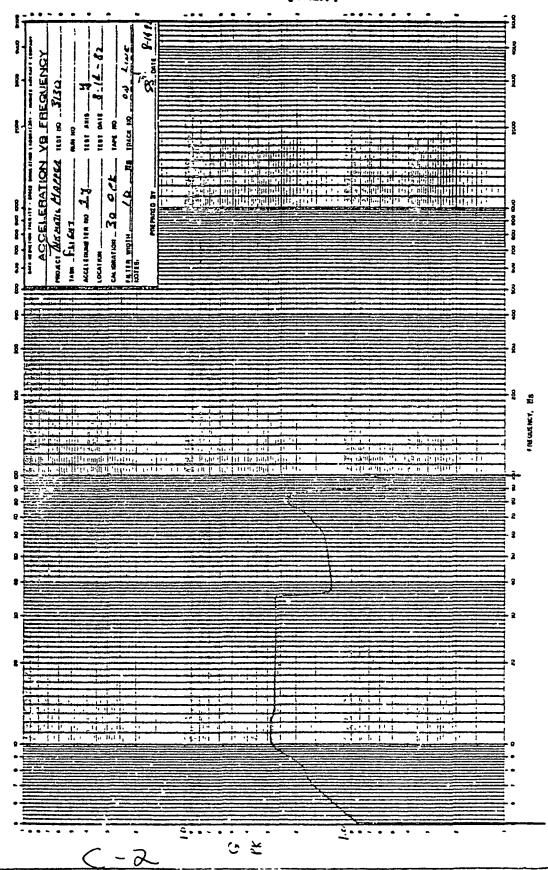
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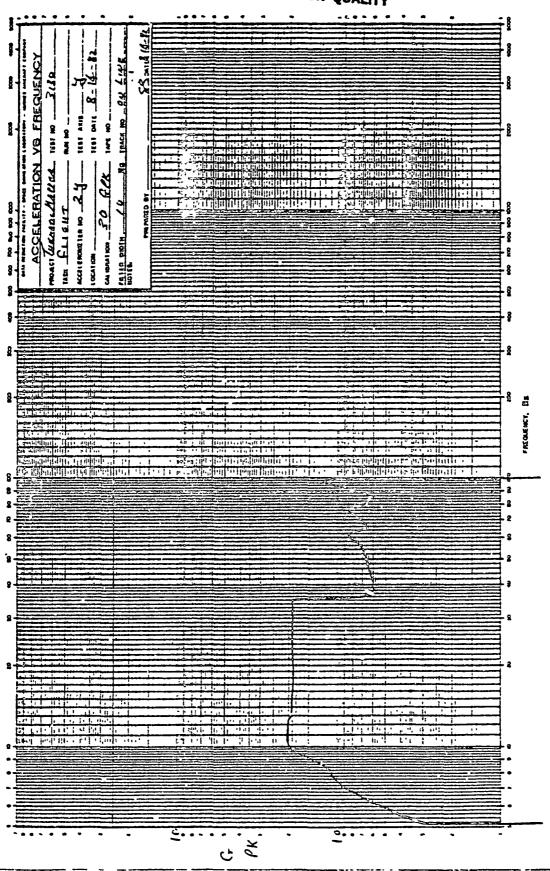
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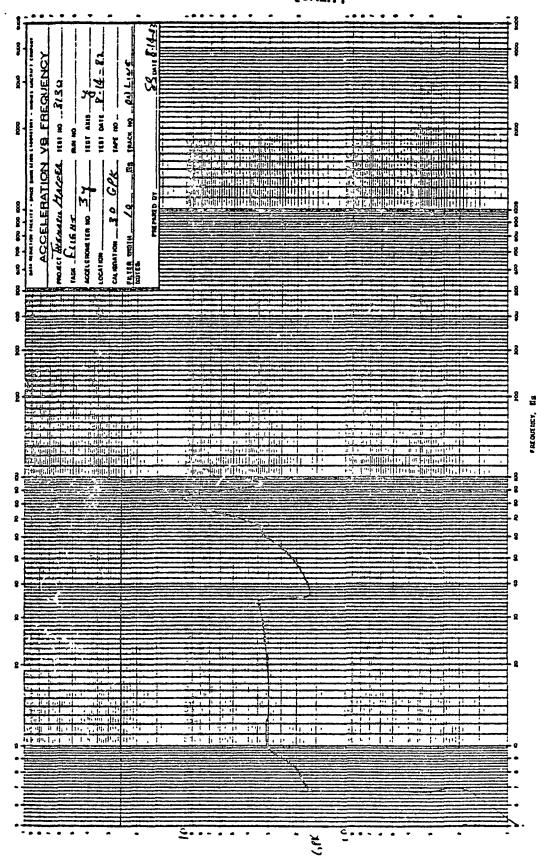




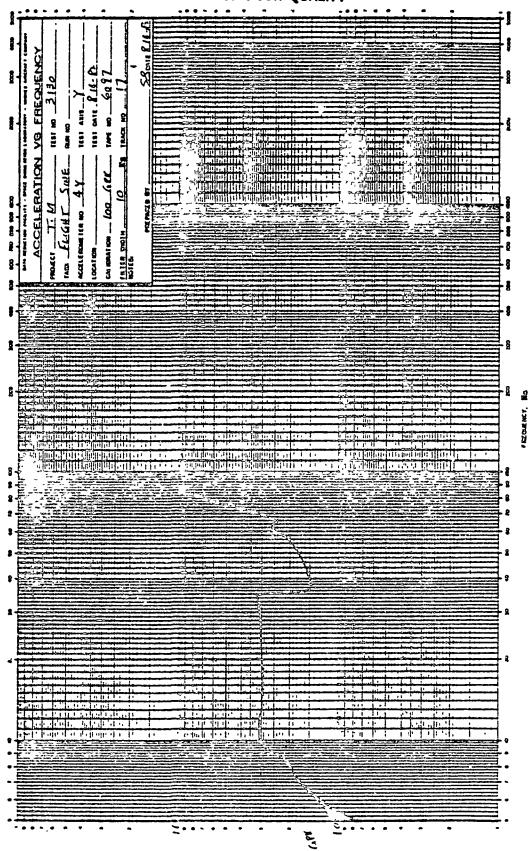
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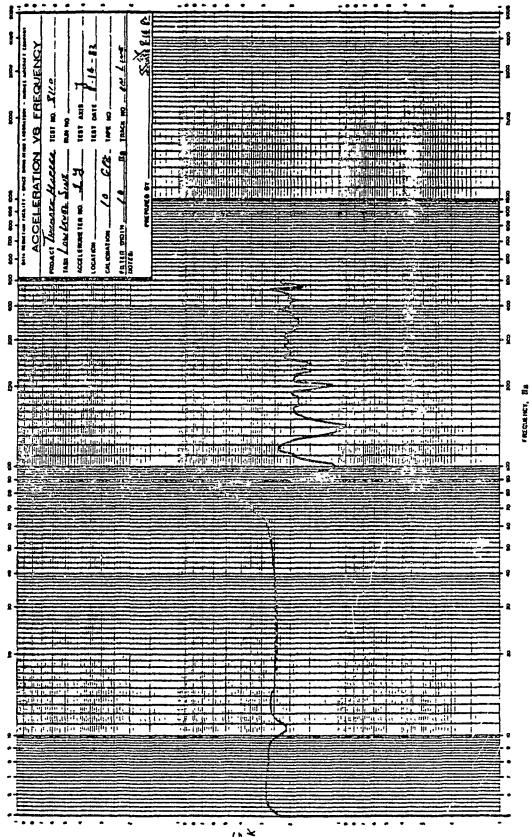


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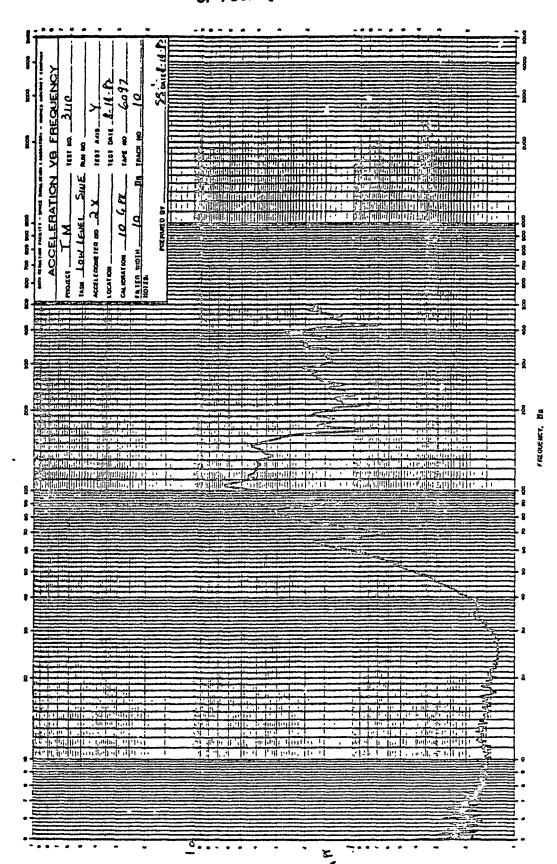


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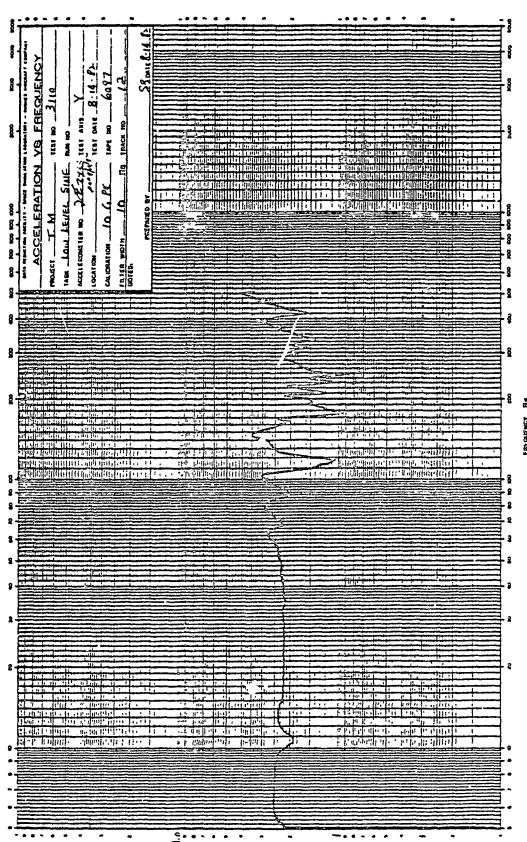
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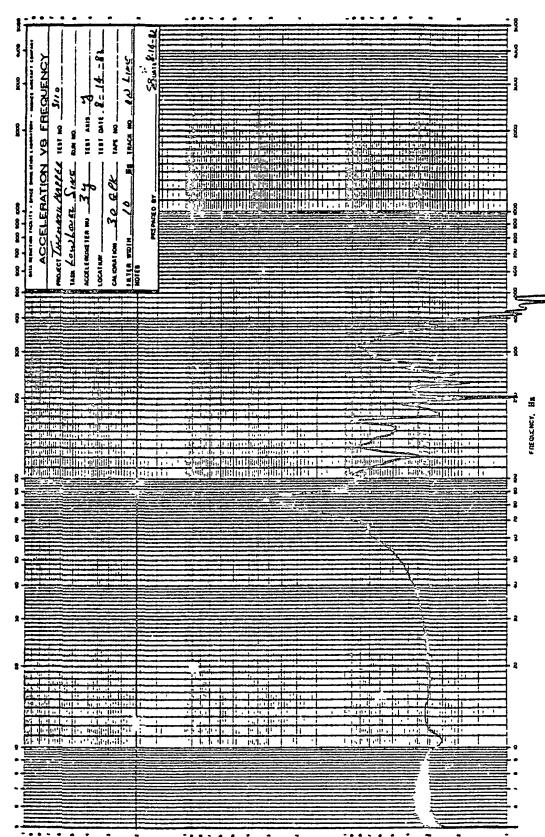
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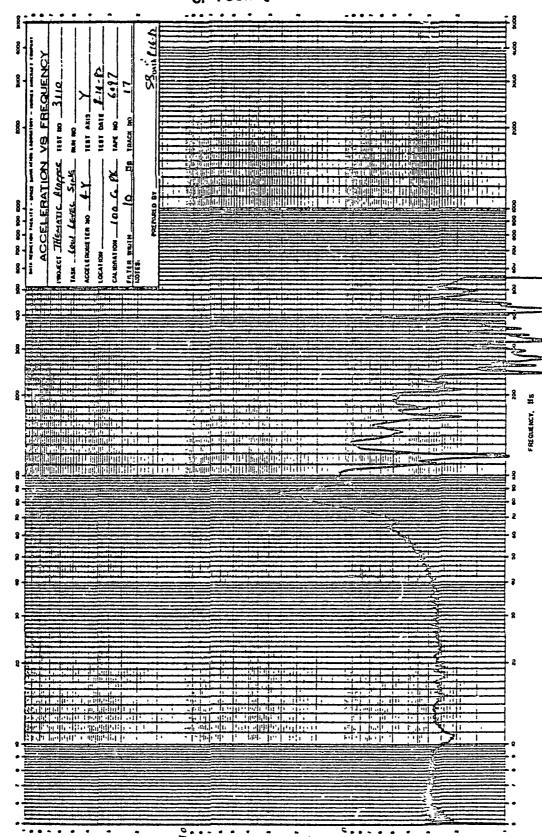
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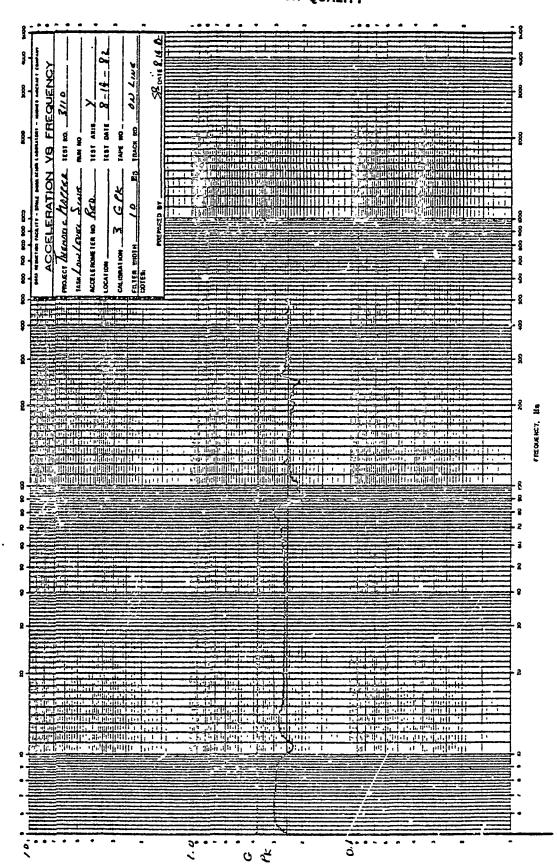


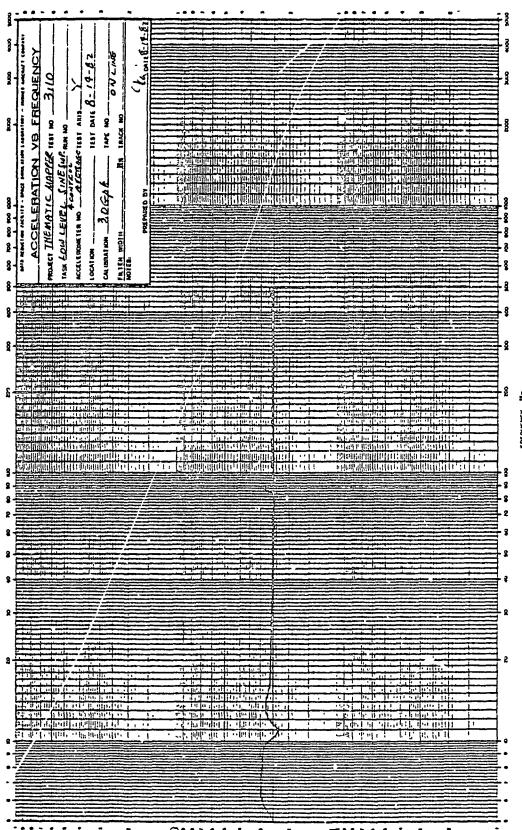
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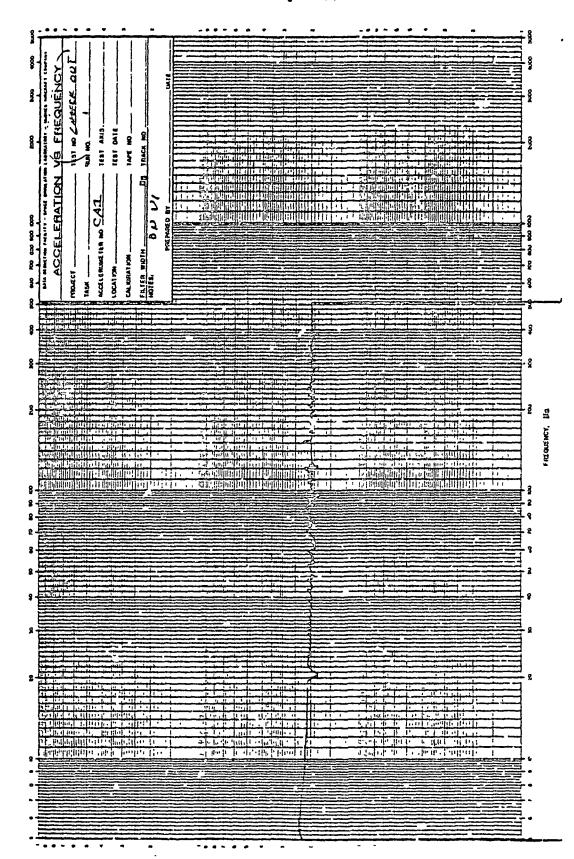




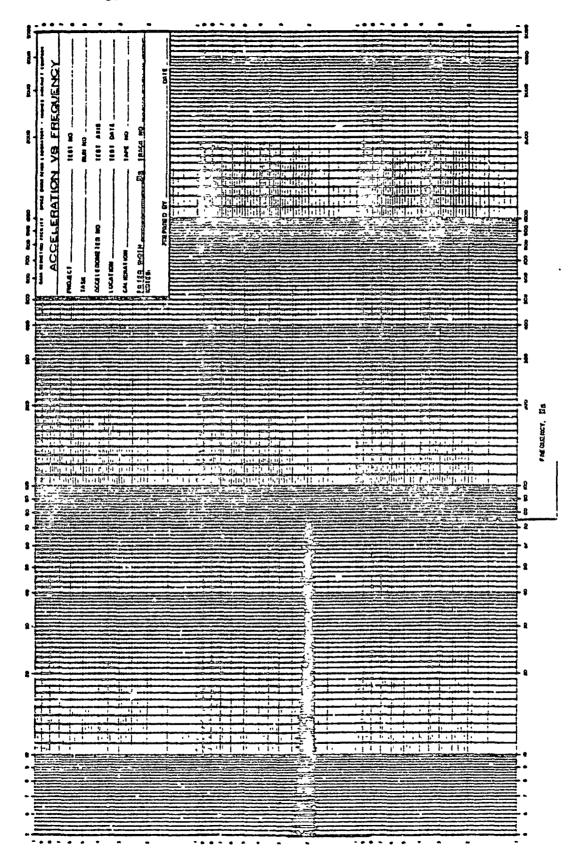
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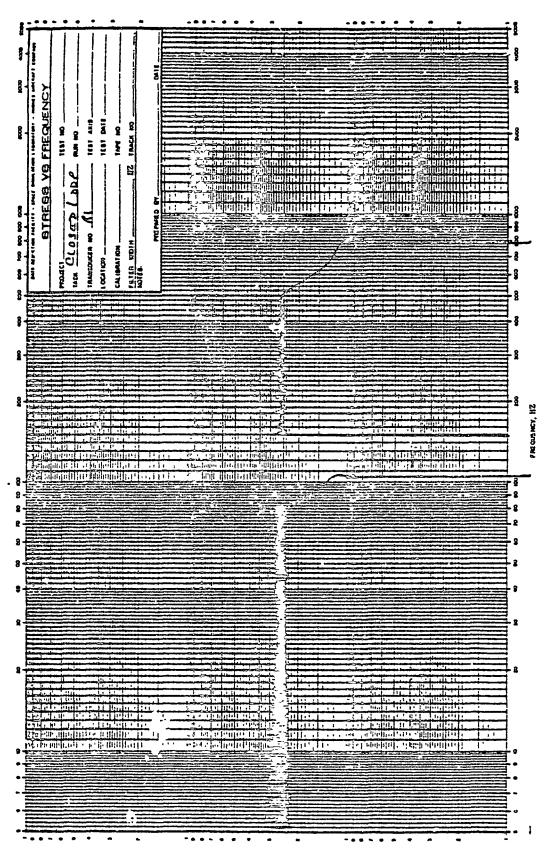
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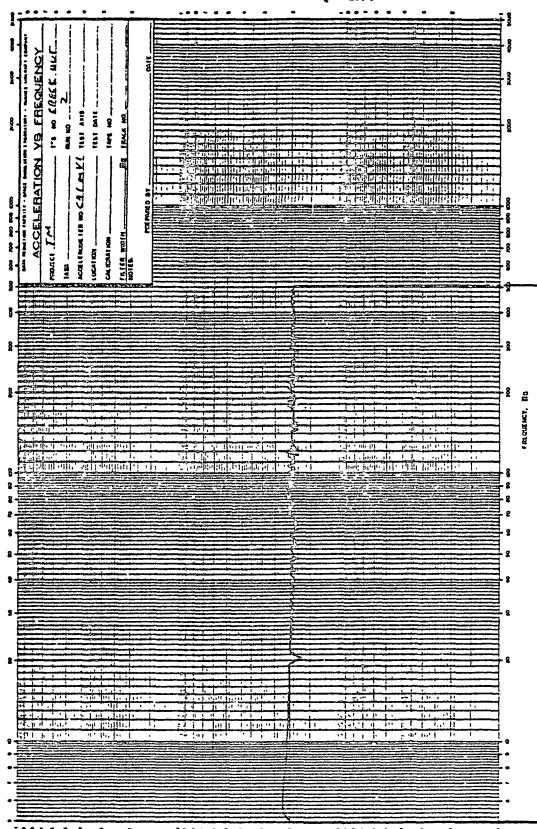


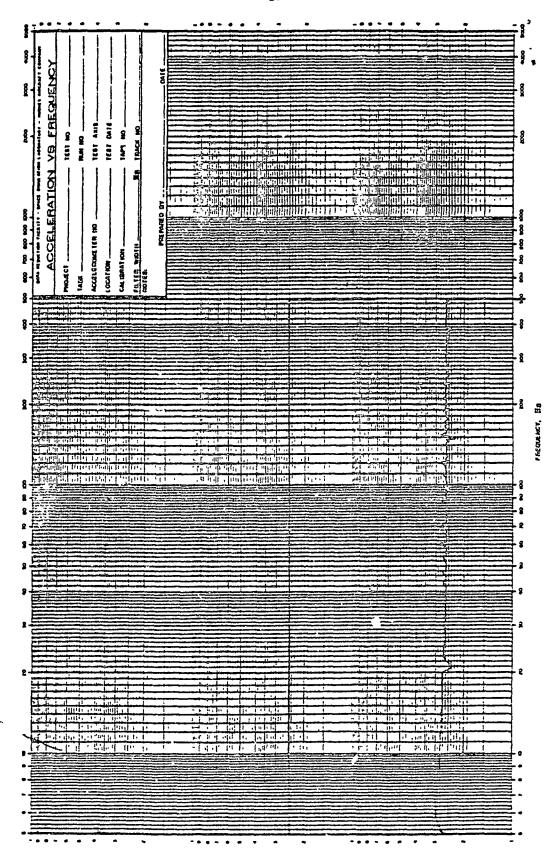


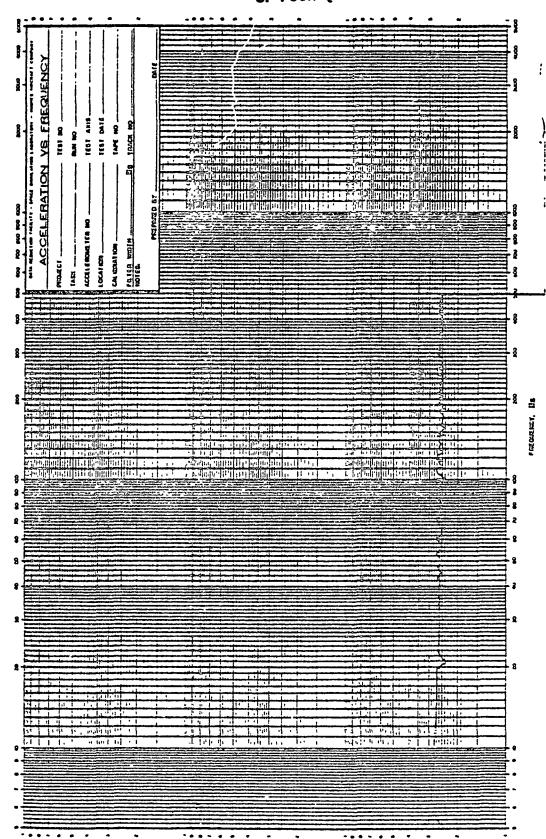
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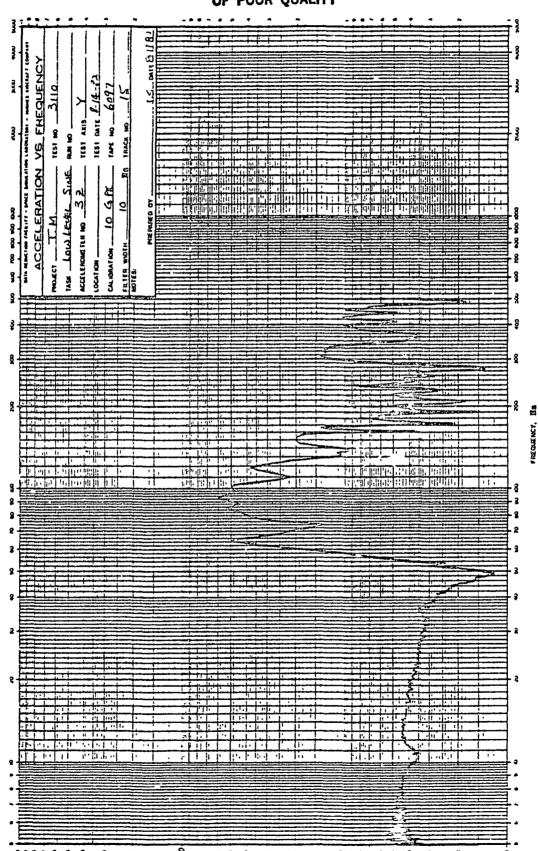
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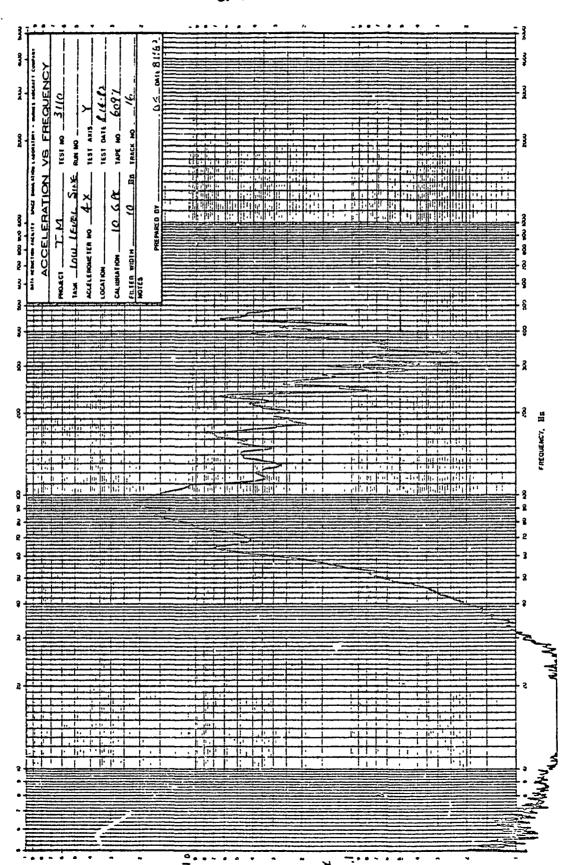
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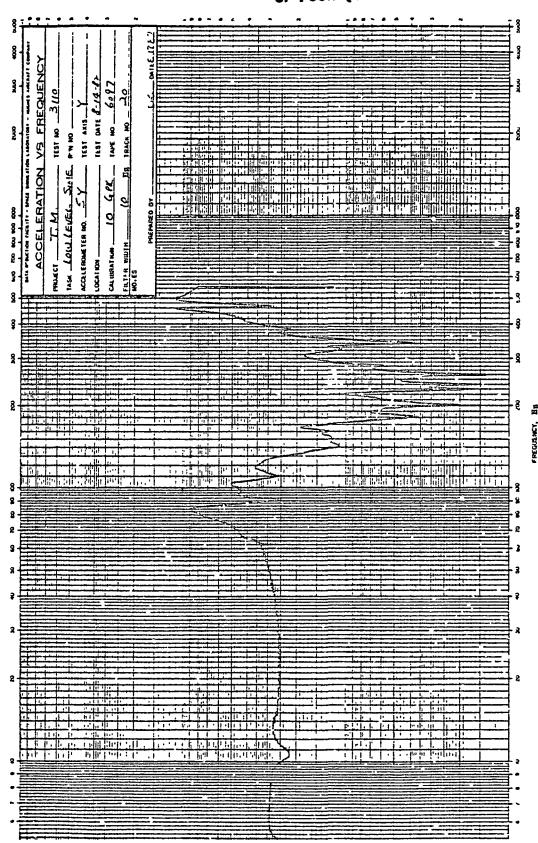
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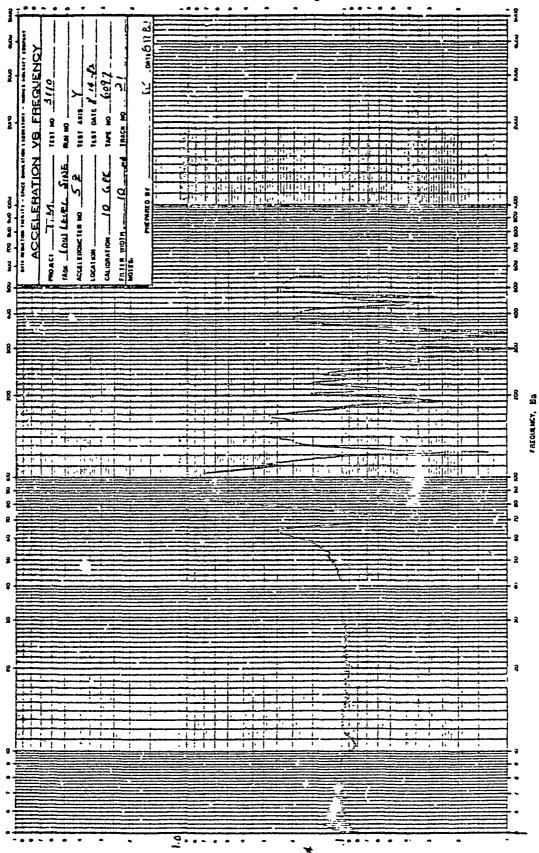
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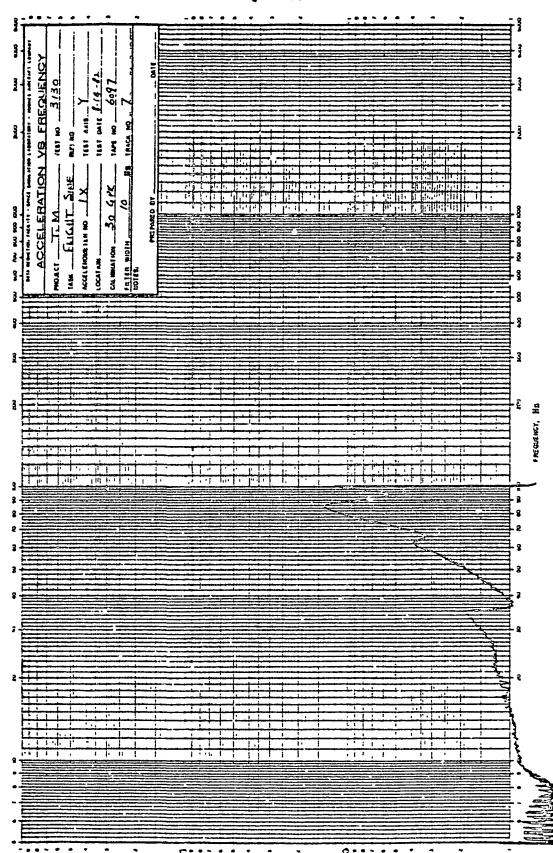
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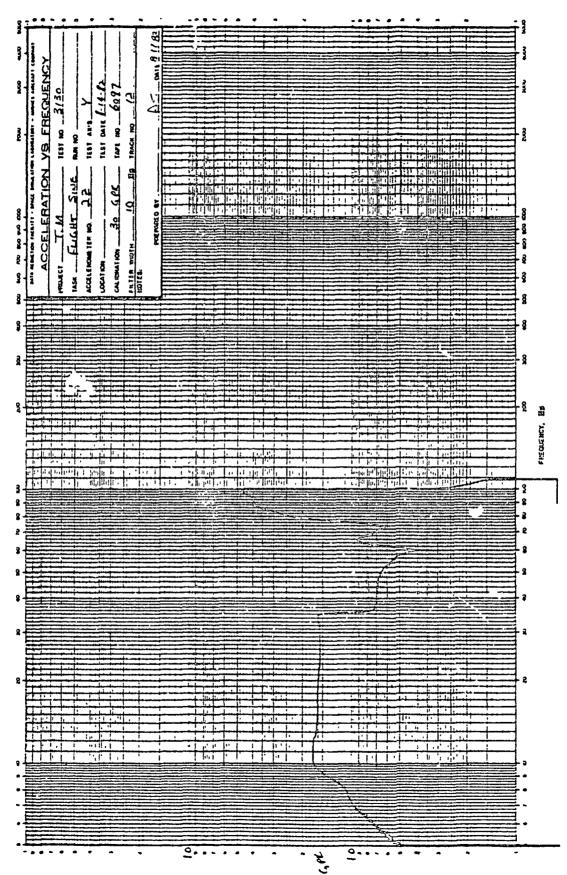




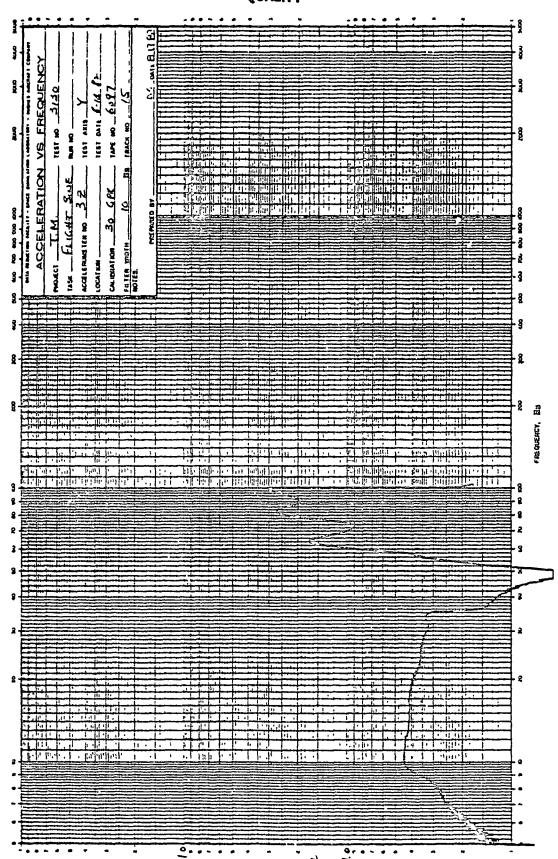


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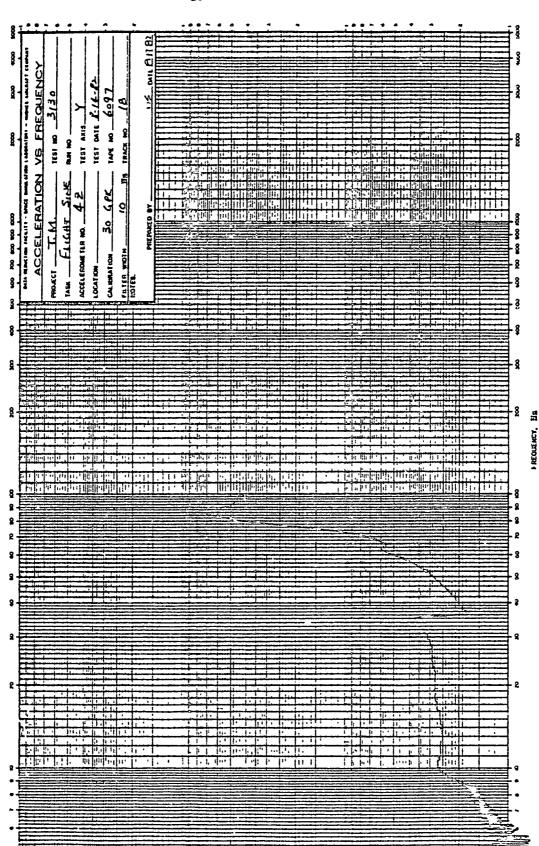
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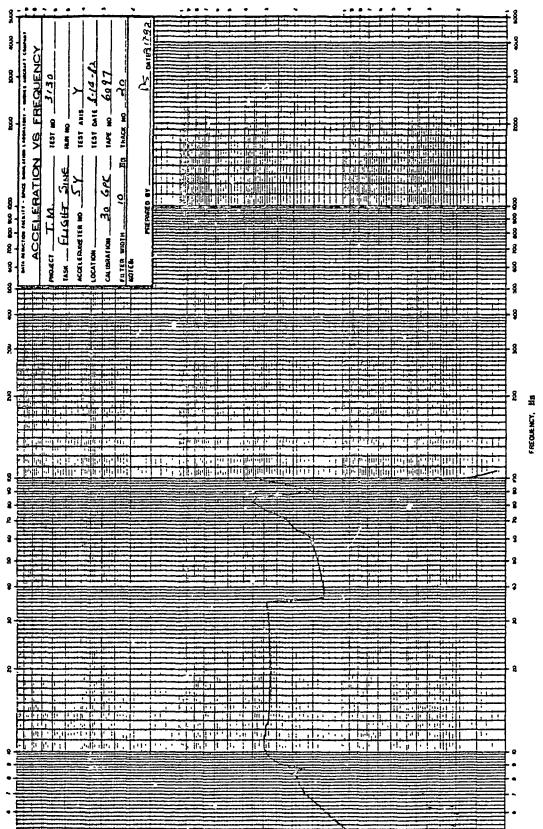
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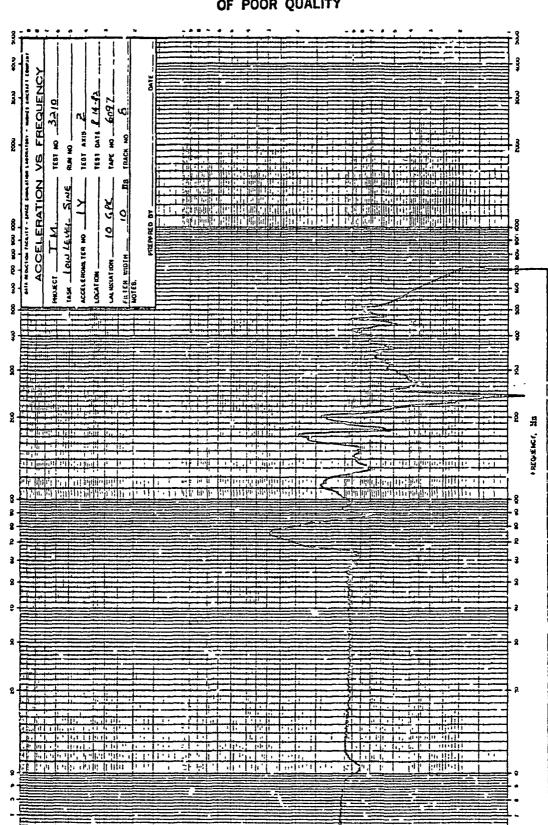
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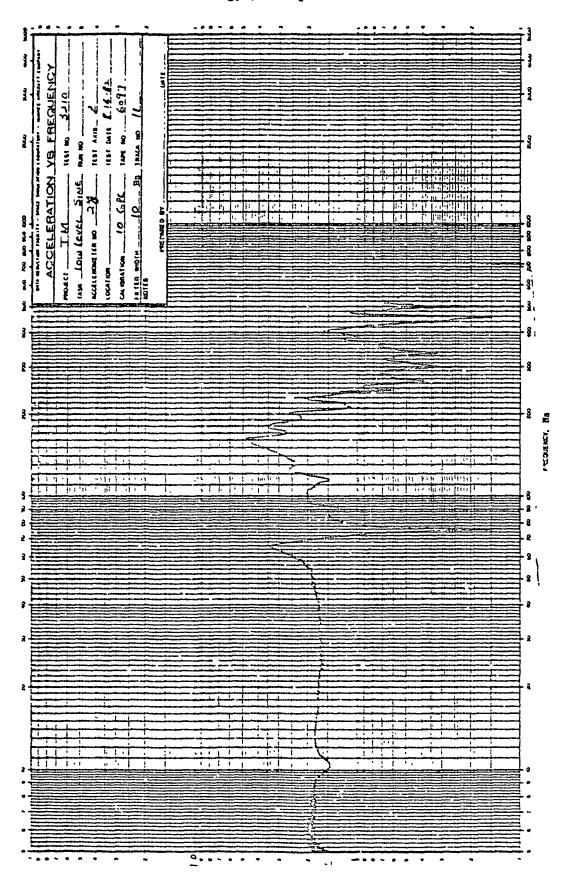
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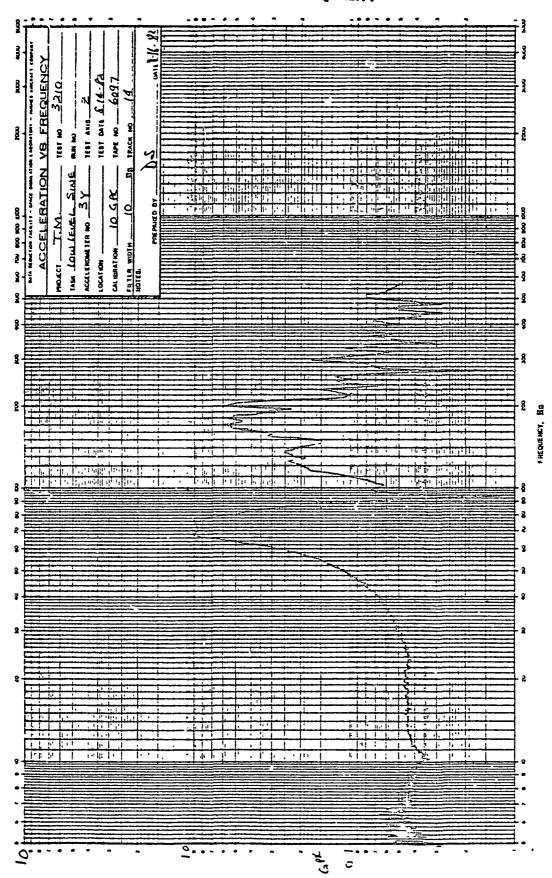
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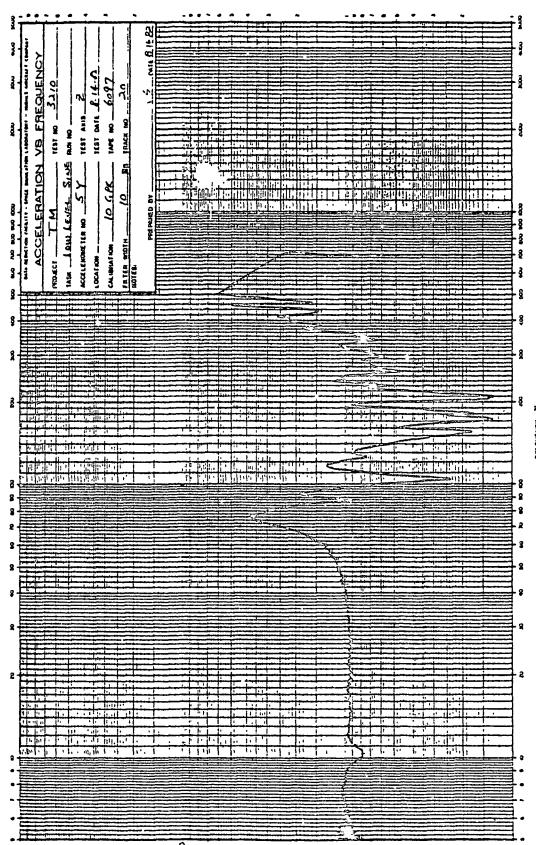
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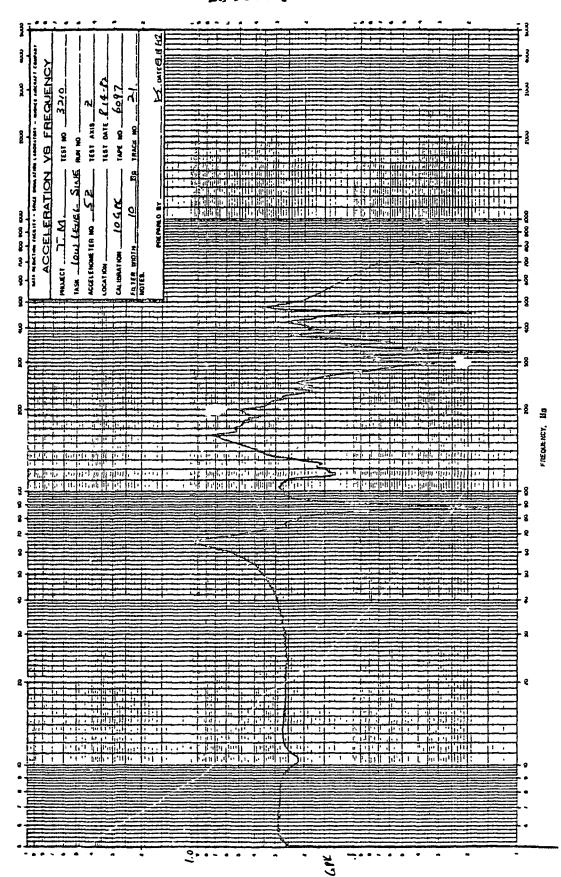
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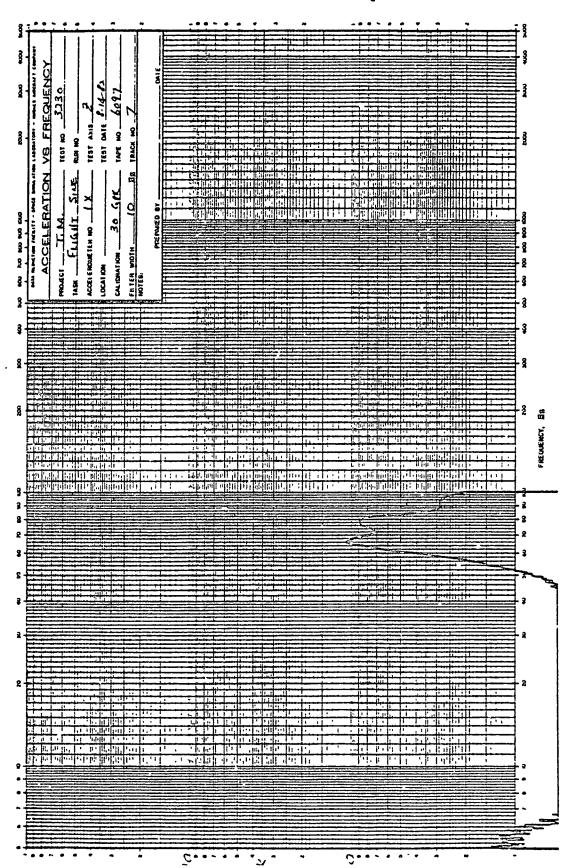
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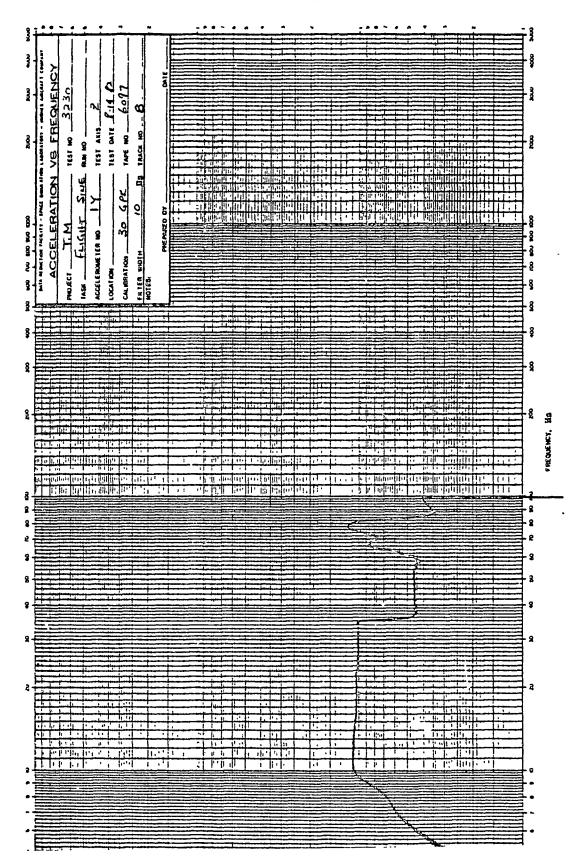
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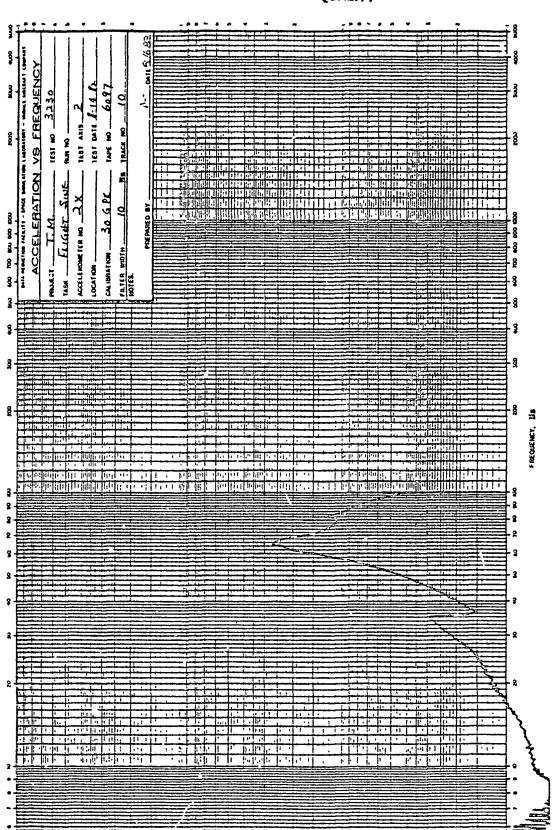


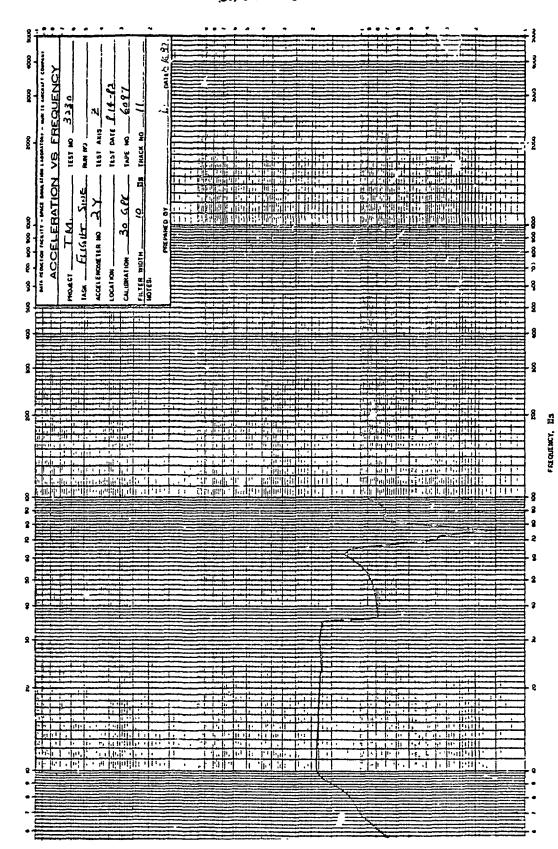




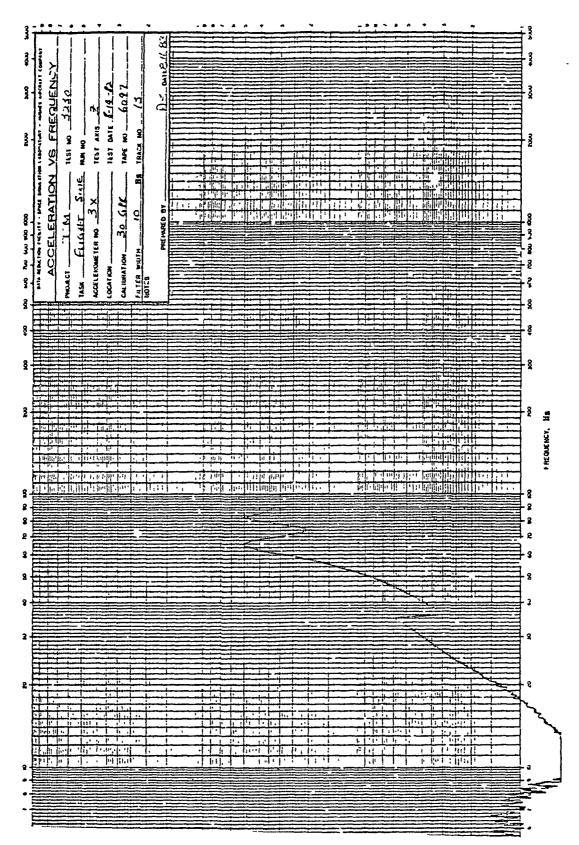
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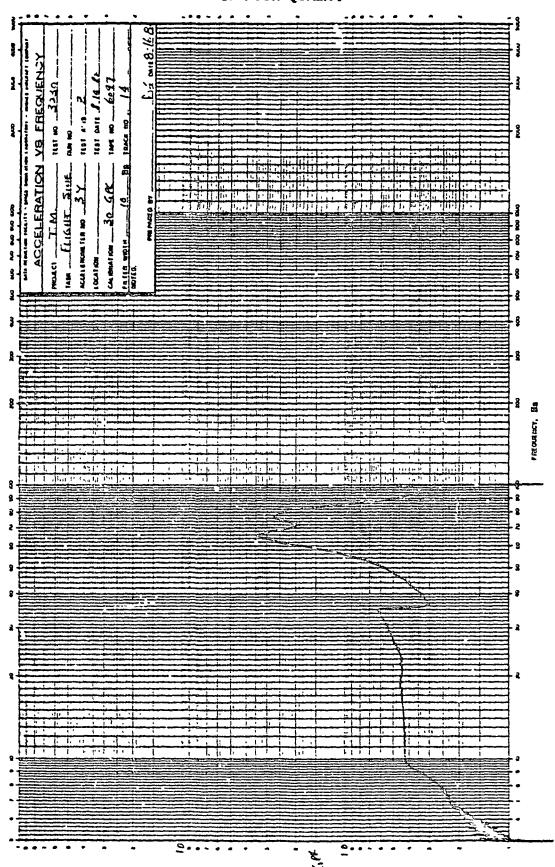
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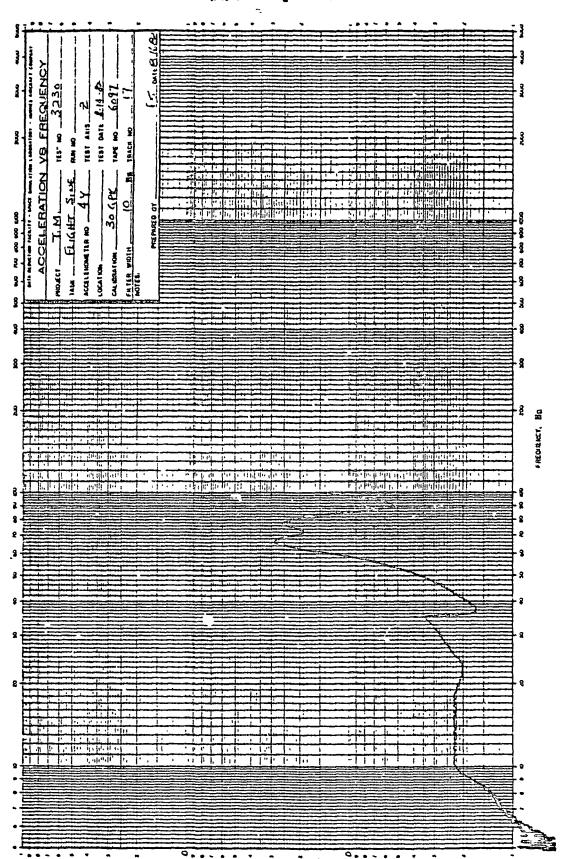


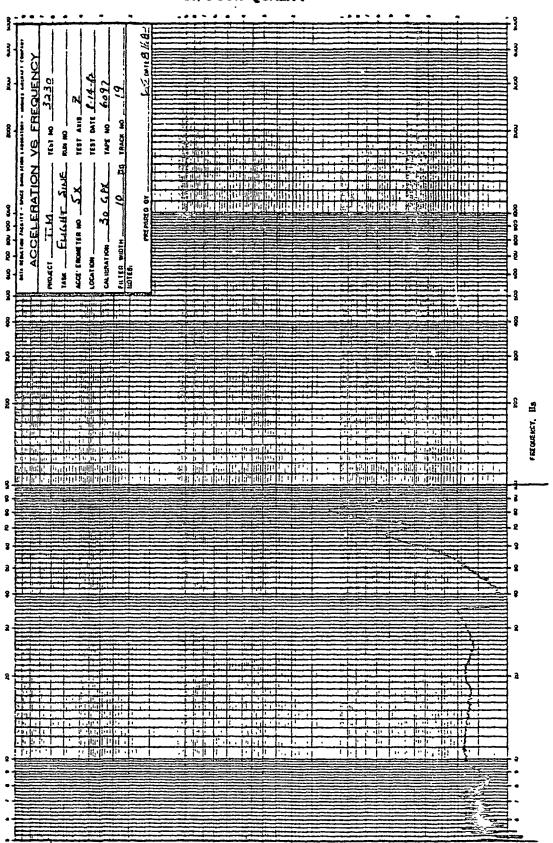
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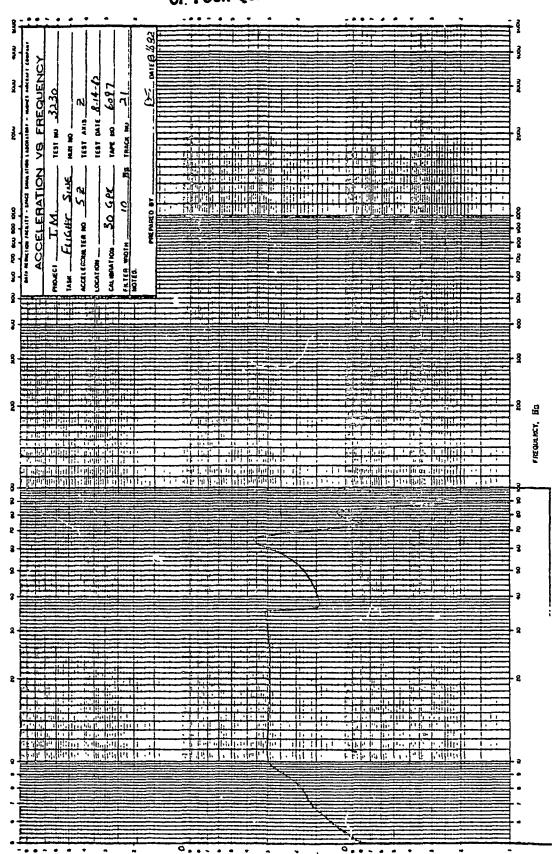


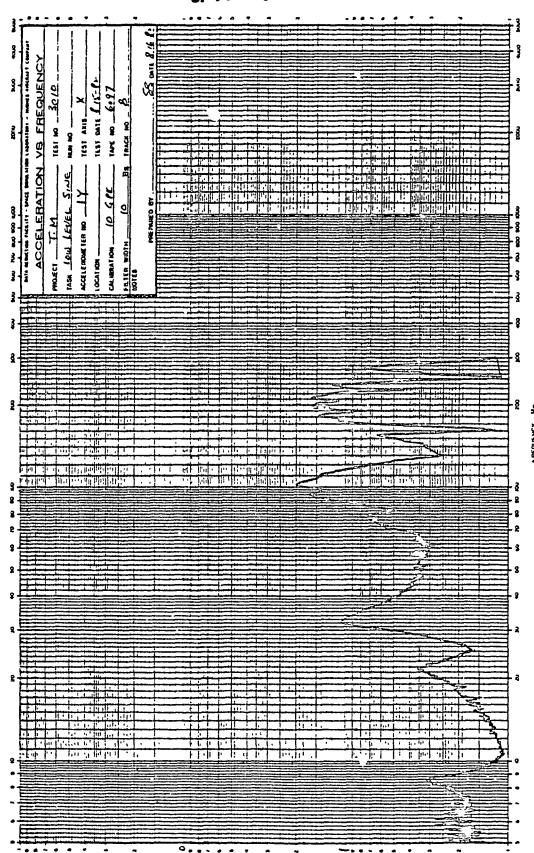
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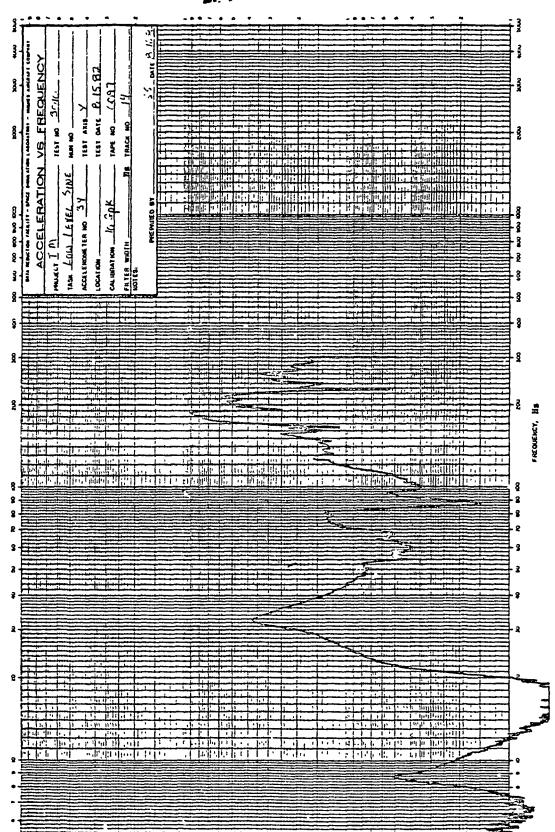
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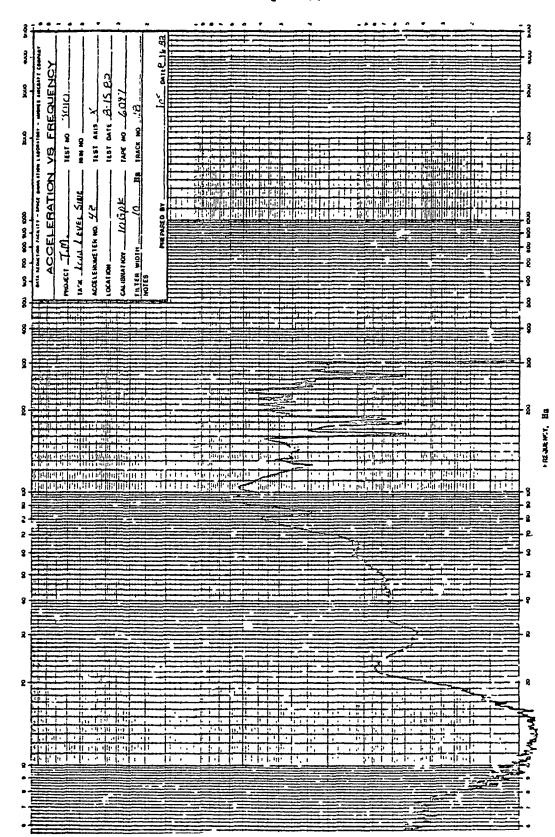
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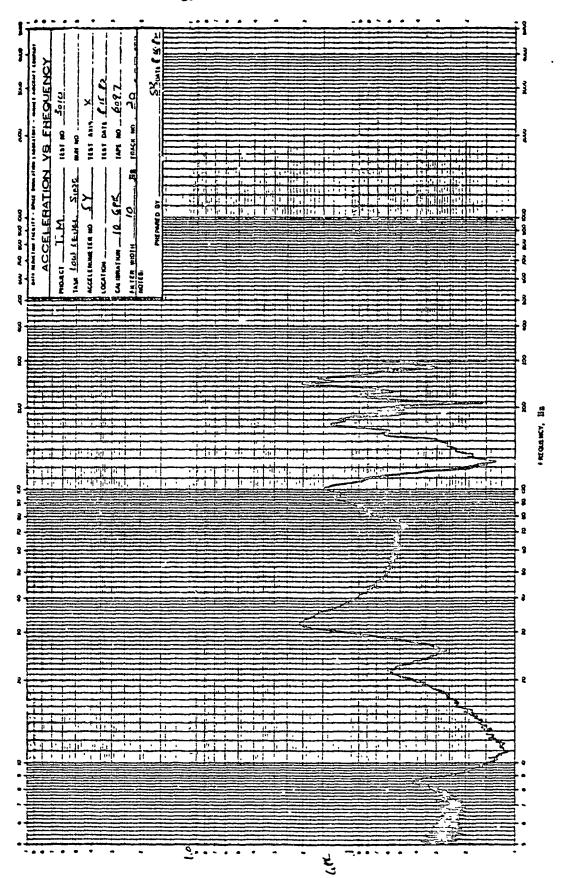
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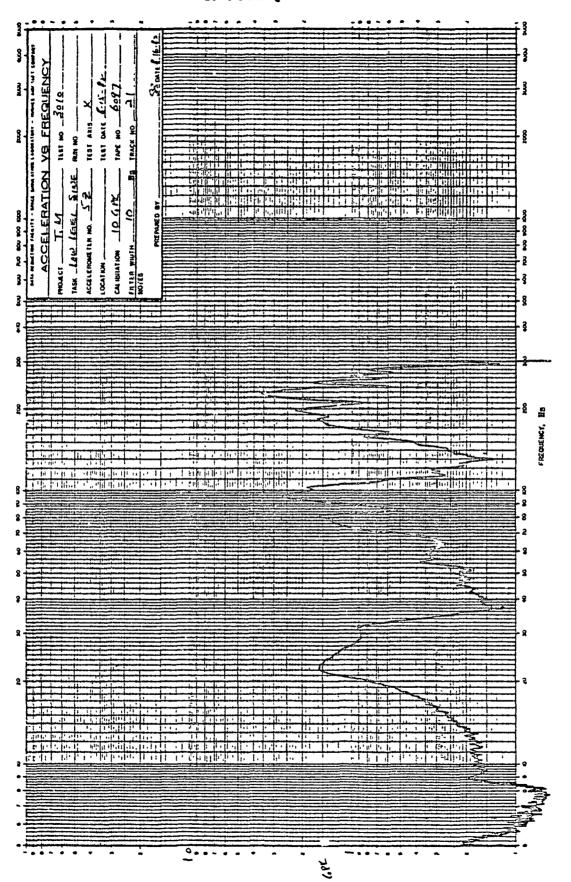
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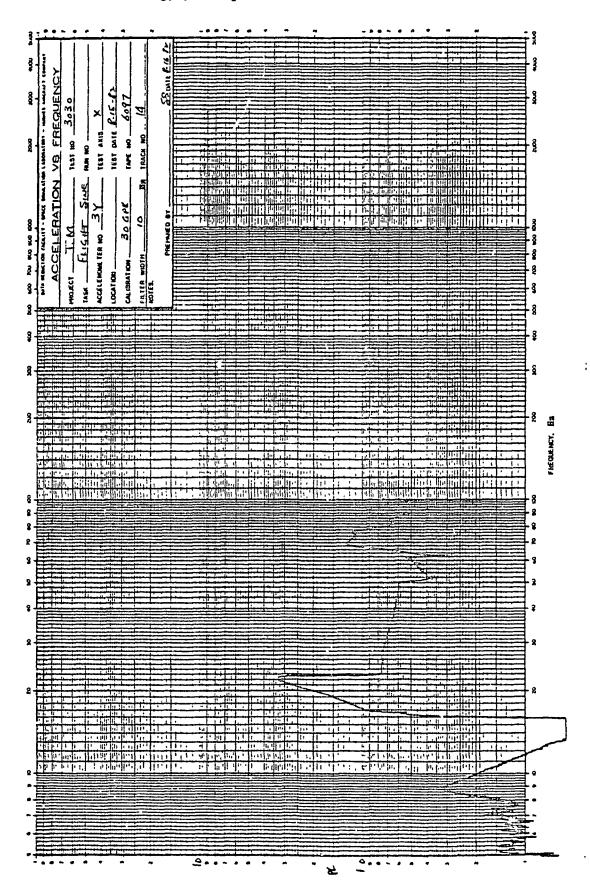
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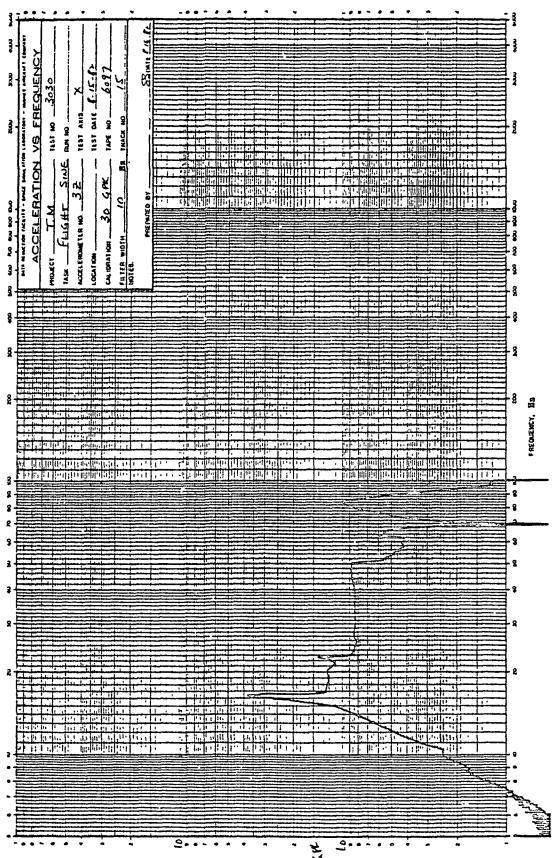
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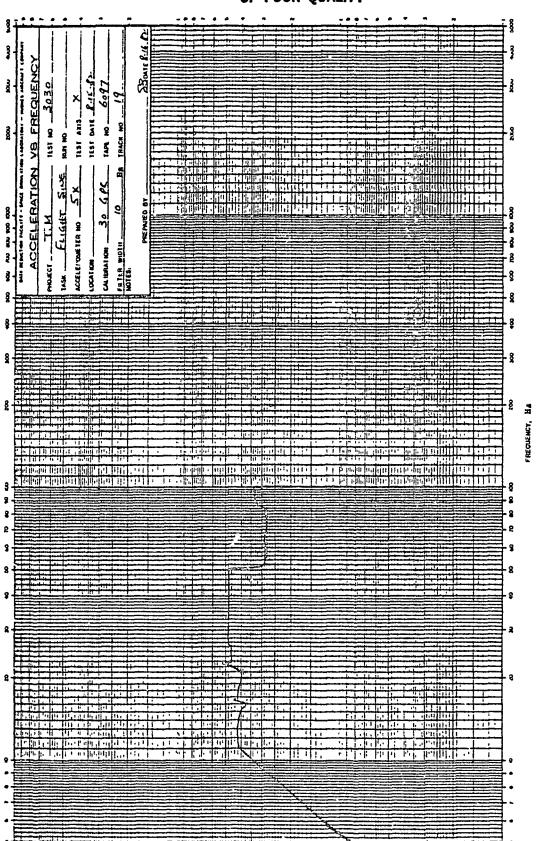
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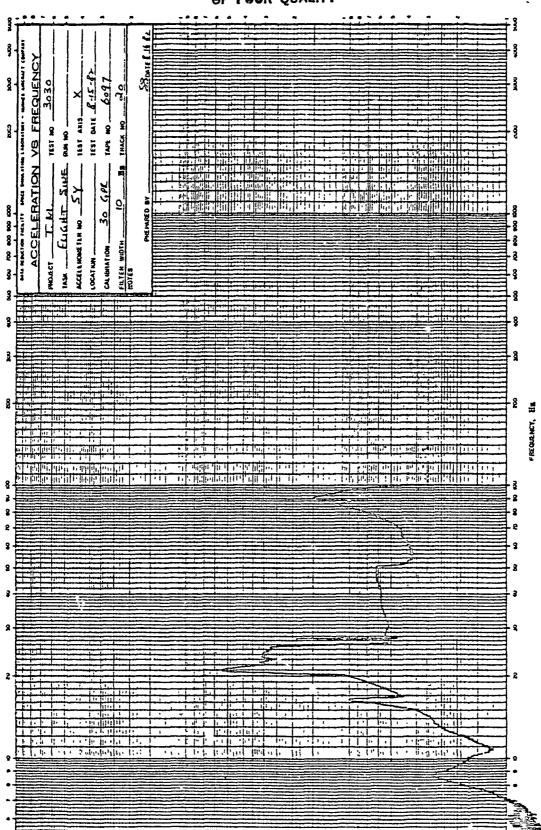
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3.2 INTEGRATION TESTS

The test sequence of the integration tests performed on the Flight Model Thematic Mapper followed that shown in table 3.0-1 of Volume II. Summary results of each test, comparisons to the instrument performance requirements, and comparison to the Protoflight and Flight models are contained in Volume II of this data package. The sections of Volume III contain the following for each test:

- (A) A reference list of documents that describe test plans, procedures, or specifications, or related pertinent data necessary for a thorough understanding of the test. Reference documents are included in the appendix to this set of data (Volume IV), compiled in the order listed hereim.
- (B) A copy of the test result summary.

3.2.1 IA01 TEST

Band 1-4 Focus, Interconnect Verification

Test Summary: HS236-7990 E.M. Kelly

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Test Specification: TP32015-501 Prime Focal Plane Coarse

and Fine Focus

Reference Documentation: HS236-7876; Flight Model, Test IA01:

Coarse Focus/MTF/Shim Requirement,

4 March 1982. P.E. Thurlow

HS236-7992; Effects on MTF for Flight Model Systems Due to Variation of Telescope Moisture Content, 17 May 1982.

J.B. Young

SANTA BARBARA RESEARCH CENTER A Subsidiery of Hughes Aircraft Company

INTERNAL MEMORANDUM

TO: Distribution

CC:

(See attached List)

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SUBJECT: IAO1R TEST RESULT SUMMARY,
T.M. Flight Model

CDMO DA BANK

REF: HS236-7990

SED-98

FROM E. M. Kelly

BLDG. B11 MAIL STA. 101

EXT. 6378

REFERENCES:

- 1. TP32015-501(G) Prime Focal Plane Coarse and Fine Focus. Test Procedure (IA01R).
- 2. History Tapes #D03006, D03007 & D03009 thru D03011.
- 3. BTCE #2 Event Log for Period 1 March '82 thru 4 March '82, 16 March '82 and 21 March '82 thru 24 March '82.
- 4. Thurlow, P.E., "Flight Model, Test IAO1: Coarse Focus/MTF/ Shim Requirement," HS236-7876, dated 3-4-82.
- 5. Young, J.B., "Effects on MTF for Flight Model Systems Due to Variation of Telescope Moisture Content," HS236-7992, dated 5-17-82.
- 6. WAIVER #W145, dated 3-25-82, to delete the post-shimming Fine Focus Test of Band 1, for Flight Model Only.
- 7. ECR #TP009/01, dated 3-11-82, to optionalize Para.5.2 (Fine Focus Check) and 5.3 (Tilt Check) at the discretion of the Optical Systems Analyst.
- 8. ECR #BT 379/01, dated 2-15-82, to update Drawing # 3533100-300-1(B) (BTCE INTERCONNECT DIAGRAM, Phase I), to add latest grounding configuration.
- 9. EO #4206A, dated 3-11-82, to optionalize Para. 5.2 (Fine Focus Check) and 5.3 (Tilt Check).
- 10. EO #4181A, dated 3-3-82, to reduce Minimum Video Signal from 17.0 to 14.0 V. P-P, and the corresponding Video Count Level from 3891 to 2867.
- 11. EO #4165A, dated 2-22-82, to add Appendix I (Vignetting Test) to procedure.

HS236-7990

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SUMMARY

This report contains the key results of IAOIR tests performed on 2 March thru 24 March 1982, per Test Procedure TP32015-501(G). The results were used for the determination of:

- 1. Initial focus position of PFPA.
- 2. The shim thickness needed between the telescope and aft optics support interface, to move the PFPA to its proper Z axis position (see Ref. 4).
- 3. Final focus position of the PFPA.

The principal objective is to place the PFPA at best focus, but the PFPA was focused in IAOl without compensating for the moisture effects of the graphite epoxy structure. Moisture analysis determined that the Flight Model Thematic Mapper had a microstrain of 35; therefore the orbital focus change would be:

 $\Delta F = 0.0077$ inch

and the collimator focus change would then be: $\Delta F_{coll} = 0.010$ inch.

From the IAOl MTF focus sensitivity curve, this 0.010 inch focus change would result in an MTF change from 0.485 to 0.46 (a ratio of 0.95); giving a final Flight Model SWR of 0.39 to 0.44 (see Ref. 5).

TEST CONFIGURATION DOCUMENTATION.

The test reported herein is an integration-level test performed on the Thematic Mapper (TM) Telescope/Aft Optics Assembly; it is a collimator-type test that uses image quality measurements to guide focal plane positioning.

This test was performed to axially position the Aft Optics Support Assembly relative to the Telescope Assembly, such that the Prime Focal Plane Array (Bands 1 to 4) is placed at the optimum focus of the Telescope.

The test was conducted with the SMA/TM Telescope/Aft Optics Assembly mounted in the TM Main Frame and oriented to align the optical axes of the TM Telescope and the Collimator.

Axial positioning of the Aft Optics Support (with FPA) relative to its interface inside the Telescope Housing was determined by

HS236-7990

12 May 1982 Page 3

TEST CONFIGURATION DOCUMENTATION (continued)

calculating the modulation transfer function (MTF) of key detectors in Band 4 during Coarse and Fine Focus Tests. These MTF data were then used to select the correct shim thickness between Telescope and Aft Optics Support Interface. The final shim thickness was then manufactured and installed to maintain proper focus. (The set up, test operations, and shim iteration in flow-chart format are shown in Figure 1-1 of the Test Procedure. Figure 1-2 of the Test Procedure schematically illustrates the test arrangement.)

Hardware configuration for this test was in accordance with Procedure TP32015-501(G). The software utilized for data collection and reduction also conformed to that identified in the procedure. Command files, data bases, and video files for all tests were recorded on History Tapes D03006, D03007 and D03009 thru D0 3011. Command and video file names are coded so that one can readily tell Band and Detector numbers, Focus Position and Cross vs. Along Track Collection Parameters (See TP32015-501(G) Para.3.5.3.5).

TEST RESULTS

This section summarizes the data which resulted from running each part of the IAO1R procedure. Table 1 summarizes the series of tests and their test conditions. This table lists each test by name and its section in the IAO1R procedure. As noted in the table, "Z-Axis Focus Range" and "Z-Axis Steps" refer to motion of the MTF wheel from its "Home" pusition at the Focal Plane of the Collimator. The "Collimator to TM Alignment" column lists the location in the TM Prime Focal Plane with which the collimator axis is aligned during each test. This alignment was adjusted for each test by rotating the TM on its Azimuth Table.

Appendix A contains a copy of the Oscilloscope Photos placed in the Data Master; the tabulated MTF values may be compared with the SWR values which may be obtained from these scope traces. Tables 2 through 10 summarize the results of the remaining test sequences. Figure 1 contains plots which are derived from this last group of tables. Figure 2 is a copy of the page in the Data Master where the new shim thickness was computed.

DISCUSSION AND CONCLUSIONS

PRE-SHIM

On 2 March 1982 the initial IAO1R Coarse Focus (IA1 CFF.DSL)

HS236-7990

12 May 1982 Page 4

PRE-SHIM (continued)

and Fine Focus (IAlFFF.DSL) tests were run. Coarse Focus results showed that the cross track and along track runs were about 0.010" apart, with cross track being within 0.004" of "HOME;" therefore a shift in Z-axis "HOME" position was not required for Fine Focus. Fine Focus results showed a -0.006" shift in peak MTF location, consequently we repeated the Fine Focus runs, although test equipment breakdown produced only cross track data.

In repeating the IAO1R fine Focus runs, an Aerotech Stage Controller became defective; it could not be computer commanded to move in the Z-axis. After unsuccessfully replacing the Aerotech Stage Controller we returned to the original controller, manually stepping the Z-axis stage at the controller while monitoring the Fine Focus (IA1FFF.DSL) Command Files. Cross track run results were nearly identical to that of the first Fine Focus runs.

On 3 March 1982 the Coarse Focus (IAlCFF.DSL) tests were repeated twice, with the Z-axis stage being manually moved--through the stage controller. Optics Systems Analyst plotted both Coarse Focus runs, with results showing "excellent agreement." From evaluation of coarse Focus and Fine Focus plotted data (of 2nd and 3rd March), Optics recommended a shim thickness reduction of 0.0618" from the trial shim thickness of 0.250", to a 0.1882" thickness. Shim to be used will be 0.188" (+ 0.001"), (see reference #4).

Specific Pre-shim test results are shown in Tables 2 through 6.

POST-SHIM

Initially we performed a Coarse Focus cross track run on 16 March 1982, to verify shim thickness. Results showed peak MTF to be within 2-3 mils of Collimator Focal Plane, verifying shim thickness and setting a good basis for proceeding to formal Fine Focus tests of Bands 1 through 4.

On 21 March 1982 we encountered computer problems in trying to run the formal Fine Focus tests. After computer and disc servicemen repaired same, we encountered video problems on Band 1. Problem was in DC restore; to correct same we moved MTF wheel pick-off point about 10(ccw) earlier. Meanwhile we tested Band 2 Fine Focus (IA1B2F.DSL) in cross track modes with only partial data collects (6 good ones out of 9). After more test equipment troubleshooting, we resumed formal testing on 22 March 1982, testing Band 2 Fine Focus (IA1B2F.DSL). Band 2 results showed peak MTF at collimator focus of:

Cross Track = +0.067"
Along Track = +0.006"

HS236-7990

12 May 1982 Page 5

POST-SHIM (continued)

On 23 March 1982 we ran Band 3 Fine Focus (IA1B3F.DSL). We repeated the along track run because the first along track run failed during data reduction--producing no printed data. Band 3 results showed peak NTF at collimator focus of:

Cross Track = +0.007"
Along Track + -0.001"

Then we ran Band 4 Fine Focus (IA1B4F.DSL). Band 4 results showed peak MTF at collimator focus of:

Cross Track = +0.004"
Along Track = -0.006"

Specific Post-shim test results are shown in Tables 7 through 10.

E. M. Kelly Test Director

P. E. Thurlow
Optics Analyst//:Systems
Engineer

W. Kei

Approval by:

G. . S. Plews, Marnager

Systems Integration & Test

Release Approval:

L. Engel, Manager

Systems Engineering Dept.

EMK:pg

Attachments: 12 + Appendix A (Pgs.1-6)

Distribution for IAO1

Attachment 1

HS236-7990

12 May 1982

TABLE 1
SUMMARY OF IAO1 TESTS

TP PARA.	TEST NAME	DATE 1982	B/D USED	Z-AXIS STEPS	Z-AXIS FOCUS RANGE	COLL TO TM ALIGNMENT
PRE-SH	IM:					
5.1.6	"SCOPE	3/1	4/9	-	<u>+</u> 0.020"	ON-AXIS
	PHOTOS"	3/1	4/9	-	<u>+</u> 0.040"	ON-AXIS
5.1.7	CF(CT,AT)	3/2	4/9	.010"	<u>+</u> 0.040"	ON-AXIS
5.2	FF(CT,AT)	3/2	4/9	.005"	<u>+</u> 0.020"	BAND 4 ODD
•	FF(CT)	3/2	4/9	.005"	<u>+</u> 0.020"	BAND 4 ODD
5.1.7	CF(CT,AT)	3/3	4/9	.010"	<u>+</u> 0.040"	BAND 4 ODD
	CF(CT,AT)	3/3	4/9	.010"	<u>+</u> 0.040"	BAND 4 ODD
POST-SHIM:						
5.1.7	CF(CT)	3/16	4/9	.010"	<u>+</u> 0.040"	BAND 4 ODD
5.6	FF(CT,AT)	3/22	2/9	.005"	<u>+</u> 0.020"	BAND 2 ODD
5.7	FF(CT,AT)	3/23	3/9	.005"	<u>+</u> 0.020"	BAND 3 ODD
5.8	FF(CT,AT)	3/23	4/9	.005"	<u>+</u> 0.020"	BAND 4 ODD

NOTES: (1) Above tests indicate runs with complete valid data collects.

- (2) When Band I video became available, after correcting DC restore problem, the computer became inoperative, so Para.5.5 (Band I Fine Focus Test) was walved by WAIVER #W145, for Flight Model only, so that Flight Thematic Mapper integration could proceed.

HS236-7990

Attachment 2
12 May 1982

TABLE 2
FIRST PRE-SHIM COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	· CT MTF	AT MTF
+.040"	.2409	.1387
÷.030"	.3254	.2504
+.020"	.4114	.3272
+.010"	.4621	.4044
.000"	.4949 .	.4603
010"	.4849	.4839
020"	.4525	.4813
030"	.3739	.4515
040"	.3020	.3854

DATA COLLECTION Date/Time: 2 March 1982/

16:15 & 17:40

HS236-7990

Attachment 3 12 May 1982

TABLE 3

FIRST PRE-SHIM FINE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.020"	.3649	.2999
+.015"	.3973	.3320
+.010"	.4246	.3604
+.005"	.4485	.4021
.000"	.4691.	.4349
005"	.4827	.4564
010"	.4816	.4706
015"	.4765	.4848
020"	.4691	.4887

DATA COLLECTION Date/Time: 2 March 1982/

20:05 & 20:30

Attachment 4

12 May 1982

HS236-7990

TABLE 4

SECOND PRE-SHIM FINE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.020"	.3397	•
+.015"	.3822	-
+.010"	.4077	•
+.005"	.4353	-
.000"	.4572 ·	•
005"	.4746	-
010"	.4792	•
015"	.4784	•
020"	.4697	-

DATA COLLECTION Date/Time: 2 March 1982/

22:50

HS236~7990

Attachment 5 12 May 1982

TABLE 5

SECOND PRE-SHIM COARSE FOCUS TEST RESULTS
(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.040"	.3611	.4868
+.030"	.4265	.4990
+.020"	.4705	.4764
+.010"	.4798	.4339
.000"	.4592	.3613
010"	.4056	.2740
020"	.3324	.1876
030"	.2458	.8208
040"	.1626	.1587

DATA COLLECTION Date/Time: 3 March 1982/

19:30 & 20:10

 $\frac{\text{NOTE:}}{\text{direction from normal: -0.040" to}} \\ + 0.040, \text{"with no apparent problems.}$

HS236-7990

Attachment 6
12 May 1982

TABLE 6

FINAL PRE-SHIM COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.020"	.1685	.6738
+.015"	.2556	.1562
+.010"	.3397	.2493
+.005"	.4144	.3272
.000"	.4621	.4143
005"	. 4851	.4663
010"	.4753 ·	.4936
015"	.4317	.4882
020"	.3607	.4628

DATA COLLECTION Date/Time: 3 March 1982/

21:50 & 22:20

HS236-7990

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Attachment 7 12 May 1982

TABLE 7

POST-SHIM COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.040"	.3234	~
+.030"	.3903	-
+.020"	.4327	-
+.010"	.4514	-
.000"	.4408	-
010"	.4023	-
020"	.3305	-
030"	.2513	-
040"	.1596	-

DATA COLLECTION Data/Time: 16 March 1982/

18:00

Attachment 8

HS236-7990

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12 May 1982

TABLE 8

SECOND POST-SHIM BAND 2 FINE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 2 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.020"	.4428	.4004
+.015"	.4455	.4225
+.010"	.4510	.4296
+.005"	.4415	.4493
.000"	.4315	.4477
005"	.4163	.4505
010"	.3870 ·	.4419
015"	.3427	.4246
020"	.3073	.4032

DATA COLLECTION Date/Time: 22 March 1982/

16:00 & 17:15

NOTE: First Post-shim Band 2 Fine Focus Test was attempted on 21 March 1982 with only partial data collects due to test equipment problems.

12 May 1982

Attachment 9

TABLE 9

HS236-7990

POST-SHIM BAND 3 FINE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 3 DETECTOR 9)

Z FOSITION	CT MTF	AT MTF
+.020"	.4138	.4212
+.015"	.4275	.4363
+.010"	.4428	.4424
+.005"	.4461	.4538
.000"	.4486	.4419
005"	.4377	.4307
010"	.4123	.4141
015"	.4038	.3978
020"	. 3846	.3569

DATA COLLECTION Date/Time: 23 March 1982/

09:00 & 10:50

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Attachment 10 12 May 1982

TABLE 10

POST-SHIM BAND 4 FINE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z POSITION	CT MTF	AT MTF
+.020"	. 3571	.4000
+.015"	.3925	.4220
+.010"	.4231	.4421
+.005"	.4370	.4560
.000"	.4536	.4569
~.005"	.4601	.4549
010"	.4549	.4390
015"	.4468	.4331
020"	.4318	.4029

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FIGURE 2

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5.4 SHIM THICKNESS DETERMINATION

5. 4. 1

Have systems analyst compare Scope Photos of Paragraph with "COMPUTER COLLECTS" and flag differences for review. 5.1E

5. 4. 2

Call systems analyst to determine needed shim thickness.

LET:

- A) T1= thickness of Shim (52055) presently in place: T1 = . . 2.250 . inch
- B) F1= measured focal length of TM Telescope; F1 = 95.295.. inch
- C) F2= measured focal length of collimator in use; F2 = . 10.9:2.2. inch
- D) dZ∞ amount modulation wheel is offset from "HOME" as determined from data generated in para. 5.2 and 5.3 (use Z-axis sign convention indicated

THEN:

T2= T1 + (F1/F2)*(F1/F2)*dZ = 0, 1892 inch

Report value of T2 to nearest 1/10000 inch.

And: delta T = (T2-T1) =6/8. inch

TI- ,2500

72 - . 1882

5. 4. 3

_If a different Shim Thickness is required, this test flow must be interupted at this point and procedural control transfered to AHRS 52532.

NOTE

The fabricated shim thickness is not necessarily T2, but may have other parameters folded into the shim thickness calculation. The shim thickness should be

APPENDIX F

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APPENDIX A (FAGES 1-6 ATTACHED)

COARSE FOCUS SCOPE PHOTOS

#\$236-7990

Date Control # 7-1

POLAROID FRINT DATA CARD

TEST TECHNIQUE: Pera. 5.1.6 SUB-STEP TEST DESCRIPTION:	DATA STORAGE NO: DATA REF. NO. DATE: 3-/-82 TIME. 2/! NO
CT HOME	TRACES: 1. Bond 4 deb 9 1. Bond 4 deb 9 1. CEBSS TRACK 2. CEBSS TRACK

NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENT

Vuer.

HORIZ TIME:

TM PLIGHT MODER

POLAROID PRINT DATA CARD

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3.2.2 IA03 TEST

Band 5 & 7 Focus, Baffle Check

Test Summary: HS236-8008 E.M. Kelly

Test Specification: TP32015-503(E) Cold Focal Plane Coarse Focus
Test Procedure

Reference Documentation: HS236-0005; IA03R Coarse Focus Determination, Cold Focal Plane; W.J. O'Donnell; 22 May 1983.

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INTERNAL MEMORANDUM

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TO: TM Distribution

Systems Test Reports

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DATE: 28 May 1882 REF: HS236-8008

SED-104

FROM: E. M. Kelly

BLDG. Bll MAILSTA. 101

EXT. 6378

SUBJECT: IA03R TEST RESULT SUMMARY, TM Flight Model

REFERENCES

- TP32015-503(E), Cold Focal Plane Coarse Focus Test Procedure (IA03R).
- History Tape #D03018. 2.
- BTCE #2 Event Log for Period 28 April thru 30 April 1982.
- O'Donnell, W. J., "IA03R Coarse Focus Determination, Cold Focal Plane," HS236-8005, dated 22 May 1982.

SUMMARY

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This report contains the key results of IA03R tests performed on 28 April thru 30 April 1982, per Test Procedure TP32015-503(E). The results were used for the determination of:

- Initial focus position of CFPA.
- The shim thickness needed at Radiative Cooler Adapter to place CFPA within focus range of inchworms.

TEST CONFIGURATION DOCUMENTATION

The test reported herein is an integration-level test performed on the Thematic Mapper (TM) Telescope/Aft Optics Assembly; it is a collimator-type test that uses image quality measurements to quide initial cold focal plane positioning.

This test was performed to axially position the Radiative Cooler Assembly, such that the Cold Focsl Plane Array (CFPA) of Bands 5, 6 and 7 is placed at the relayed focus of the telescope within trimming range of the inchworm adjustments. A positional specification of + .015 inch has been established as the allowable deviation from the optimum focal position indicated by a central Band 5 detector during this test.

HS236-8008

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28 May 1982 Page 2

TEST_CONFIGURATION DOCUMENTATION (continued)

The test was conducted with the TM Telescope/Aft Optics Assembly mounted in the TM main frame and oriented to align the optical axes of the TM Telescope and the Collimator.

Axial positioning of the Radiative Cooler relative to its interface with its Adapter to the Telescope Housing was determined by calculating the Modulation Transfer Function (MTF) of a Band 5 central detector. These MTF data were then maximized by shim thickness trumming at the Radiative Cooler and Adapter interface until the correct shim thickness has been determined. This final shim thickness was then manufactured and installed to maintain this proper focus.

TEST RESULTS

This section summarizes the data which resulted from running the IA03R test procedure. Table I summarizes the specific tests and their test conditions. This table lists each test by name and its section in the IA03R procedure. As noted in the table, "Z-Axis Focus Range" and "Z-Axis Steps" refer to motion of the MTF wheel from its "Home" position at the Focal Plane of the Collimator. The "Collimator to TM Alignment" column lists the location in the TM Prime Focal Plane with which the Collimator axis is aligned during each test.

Table 2 summarizes the results of the Coarse Focus Tests, in cross and along track modes. Figure 1 contains plots which are derived from these Coarse Focus Tests. Figure 2 is a copy of the page in the Data Master where the new shim thickness value was computed.

Appendix A contains a copy of the Oscilloscope Photos placed in the Data Master; the tabulated MTF values may be compared with the SWR values which may be obtained from these scope traces.

DISCUSSION AND CONCLUSIONS

On 28 April 1982, during pre-IA03 set-up and check-out, some Band 5 video detectors appeared to have low signal levels. We ran an open-pattern-value collect (IVTA ·DSL) and, for troubleshooting purposes, a reverse O-P-V collect (IVTA REV ·DSL). This method enabled us to check all detectors of Bands 5 and 7 through both System Interface Unit(SIU) Channels("A" and "B"). From these collects we determined that Band 5: Det. 1 (Ch A), Det. 4 (Ch A), Det. 5 (Ch A) and Det. 9 (Ch A and B) all had low signal levels.

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28 May 1982 Page 3

DISCUSSION AND CONCLUSIONS (continued)

Further investigation determined that it was a test equipment problem, maybe inside the SIU. Consequently, in Band 5, we used Detector 8 instead of Detector 9 in our subsequent tests: Scope Photos (Para.5.1.6) and Coarse Focus (Para.5.2).

On 29 April 1982, during further troubleshooting, scope photos were taken: at "Home" (0.000"), +0.040" and +0.080," but the photos showed only insignificant change of scope SWR values (see APPENDIX A, Scope Photos taken 14:35 to 15:05). Then we looked at Band 4 Det. 8 and Band 7 Det. 8 for comparison (see Scope Photos taken 16:50 and 16:55). Results showed that Band 4 Det. 8 was at peak focus, whereas Band 7 Det.8 video was low--comparable to Band 5 Det. 8 (since they are both Cold Bands). Further investigation of "best" focus revealed that it peaked at approximately +0.300" (see Scope Photos taken 17:00 to 17:35). Using best focus of +0.300" as Z-Axis "Home," we successfully ran the Coarse Focus Test (IA3CFF.DSL) in cross track mode.

On 30 April 1982 we first took the Along Track Scope Photos (see Appendix A, photos taken at 10:15 to 10:45). Then we successfully completed the Coarse Focus Test (IA3CFF.DSL) by running in the along track mode. Finally we took the Cross Track Scope Photos (see photos taken at 13:00 to 13:15, plus HOME photo taken 16:30 on 29 April 1982). Z-Axis HOME scope trace was observed (on 30 April 1982) to be identical to the scope photo of the previous day. Band 5 Det. 8 results showed peak MTF at collimator focus of:

Cross Track = 0.289"

Along Track = 0.310"

From this data it was determined that a shim thickness of 0.1878" was required for the Radiative Cooler and Adapter interface. Original shim was 0.132", giving a change of:

0.1878" - 0.132" = 0.0558"

(See Figure 2)

HS236-8008

28 May 1982 Page 4

DISCUSSION AND CONCLUSIONS (continued)

For more detailed computation see Ref. 4 memo.

E.M. Kelly
Test Director

D.G. Brandshaft

Systems Engineer/Optics
Analyst

Approved by:

G.S. Plews, Manager

Systems Integration & Test

Release Approval:

J.L. Engel, Manager

Systems Engineering Dept.

EMK: pg

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Attachments: 8 + Appendix A (Pgs. 1-14)

Distribution for IA03

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28 May 1982 Page 5

TABLE 1

SUMMARY OF IA03 TESTS

TP PARA.	TEST NAME	DATE (<u>1982</u>)	B/D USED	Z-AXIS STEPS	Z-AXIS FOCUS RANGE	COLL TO TM ALIGNMENT
5.1.6	"SCOPE	4/29	5/8	-	± 0.040"	ON-AXIS
(CT)	PHOTOS"	4/29	5/8	-	<u>+</u> 0.080"	ON-AXIS
5.1.6	"SCOPE	4/30	5/8	-	± 0.040"	ON-AXIS
(AT)	PHOTOS"	4/30	5/8	-	± 0.080"	ON-AXIS
5.2	CF (CT)	4/29	5/8	.020"	<u>+</u> 0.080"	ON-AXIS
5.2	CF (AT)	4/30	5/8	.020"	<u>+</u> 0.080"	ON-AXIS

NOTES:

- (1) Above tests indicate runs with complete valid data collects, with "HOME" at "best focus" of CFPA.
- (2) CF = Coarse Focus Test CT = Cross Track Test Mode
 AT = Along Track Test Mode

HS236-8008

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28 May 1982 Page 6

TABLE 2

(30 METER BAR PATTERN)

(BAND 5 DETECTOR 8)

Z POSITION	CT MTF	AT MTF
+.080	.0829	.0275
+.060	.0207	.1583
+.040	.1387	.3076
+.020	.3200	.4060
.000	.4346	.4192
020	.4516	.3445
040	.3562	.1717
060	.1744	.0302
080	.0566	.1041

DATA COLLECTION: Date/Time: (CT) 29 April 1982/17:10

(AT) 30 April 1982/10:40

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FIGURE 2

28 May 1982 Page 8

5.3 SHIM THICKNESS DETERMINATION

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5. 3. 1

Call systems analyst to determine the Radiative Cooler needed shim thickness.

LET:

- A) T1= thickness of Shim (52051) presently in place:
- ·B) Fi= measured focal length of TM Tolescope times 0.5;
- C) F2m measured focal length of collimator in use;
- D) dZ= amount modulation wheel is offset from "HOME" (use Z-axis sign convention indicated in Fig. 4-2); and
- E) T2= new shim thickness.

T1= ... 0.132 inch

F1= ... 95,995/2 inches

120

F2= ... /09, 22 ... inches

dZ= ... 0.289 ... inch

THEN:

T2 = T1 + (F1/F2) + (F1/F2) + dZ = ... 0./878. inch

Report value of T2 to nearest 1/10000 inch.

THEREFORE:

delta T = (T2-T1)=0.0558 ... inch \$\frac{1}{2}\$

5, 3, 2 Power down equipment not required during the fabrication of the

5, 3, 3

Remove Radiative Cooler per AHRS 52532.

5, 3, 4

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Appendix A 28 May 1982

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APPENDIX A

COARSE FOCUS SCOPE PHOTOS

(PAGES 1-14 ATTACHED)

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TEST DESCRIPTION: ___SCOPE

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NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENTS

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NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENT:

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NOTE USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENTS APPENDIX A Page 7 %.

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PROC. 8K: 779326/	5~51Z	POLAROID PRINT D	DATA CÀRÚ DATA STORAGE NO.
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PROC. BK: TP 3 2 6 / TEST TECHNIQUE TEST DESCRIPTION:	5-513 Scope	POLAROID PRINT D REV: <u>&</u> SUBSTEP <u>S.A.C.</u> PHOTES	DATA STORAGE NO DATA REF. NO DATE: 4-30-94 TIME: 16.2
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NOTE USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING CONTRACT

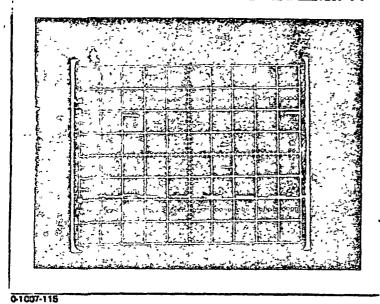
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(P.oe A.T. Coldat)

POLAROID PRINT DATA CARD

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D-1007-115	OROSS-7R	ADDITIONAL ENGINEERING CON (PINAL RUN) (Post-test sectors)
F-/	OROSS-7R POLAROID PRINT	ADDITIONAL ENGINEERING CON PACE (PINAL RUN) (Post-test secs DATA CARD DATA STORAGE NO.
F-/	OROSS-7R POLAROID PRINT REV: SUB-STEP	DATA CARD DATA STORAGE NO. DATA REF. NO.
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PROC. BK	POLAROID PRINT REV: SUB-STEP	DATA CARD DATA STORAGE NO. DATE. TRACES. 1.
PROC. BK	POLAROID PRINT REV: SUB-STEP	ADDITIGNAL ENGINEERING COM PACE (FINAL RUN) (Post-Just neces DATA CARD DATA STORAGE NO. DATA REF. NO. TIME: TRACES. 1. 2. 4.
PROC. BK	POLAROID PRINT REV: SUB-STEP	DATA CARD DATA STORAGE NO. DATE. TRACES. 1.

ORIGINAL PAGE IS OF POOR QUALITY POLAROID PRINT DATA CARD PROC. 8K- TP 32015- 50 7 DATA STORAGE NO: __ SUB-STEP _ 5.1.6 TEST TECHNIQUE: ____ DATA REF. NO: __ SCOPE PHOTOS TEST DESCRIPTION: __ TRACES: , Band 5 Det. 8 2 20 + 0,080 6 STATE V= 5 V/cm Z-00 +0.0886 NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENTS Za+0.008" 4-29-82 (16:50) (FINAL RUN)
(Pat-test reckeck) CROSS -TRACK POLAROID PRINT DATA CARD REV: DATA STORAGE NO. __ SUB-STEP 5.66 TEST TECHNIQUE: ____ DATA REF. NO. DATE: 4-19-9-0 SCOPE TEST DESCRIPTION: __ TRACES. ₹ @ -0.080

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3.2.3 IA04 TEST

Focus Verification, Rotational Alignment, Band-to-Band Registration

Test Summary: HS236-8026A b. Brandshaft HS236-8033 E. Kelly

Test Specification: TP32-15-504 Cold Focal Plane Fine Focus and Band-to-Band Registration

Reference Documentation: None

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SANTA BARBARA RESEARCH CENTER A Subsidiery of Hughes Aircreft Company

INTERNAL MEMORANDUM

TO: J. L. Engel

cc: TM Data Bank (2)

DATE: 28 June 1982

REF: HS236-8026 A

SED-118 A

SUBJECT: IA04R Preliminary Test Results

(With Changes in Y-DISPLACEMENT IFOV's as noted)

FROM: D. Brandshaft

BLDG. Bli MAIL STA. 40

EXT. 6343

OBJECTIVES:

1. Establish focus of cold focal plane.

2. Test inchworms and LDVT's.

Establish prime to cold focal plane registration.

RESULTS:

Figure 1 shows the final measurement of the cold focal plane focus. The measured MTF at focus (0.000") and at the predicted focus after dryout of the carbon epoxy telescope (-0.024") are adequate. :

All three inchworm-LDVT pairs worked well.

Table 1 shows the displacements of the bands from their nominal locations. Cold to warm focal plane registration is adequate. Note, however, that bands 5 and 7 are too far apart. This anomaly is dealt with in failure report 5777.

D. Brandshaft

DB:pg

Attachments: 2

Distribution: TM Lists B,C,H,I,J,K,U

USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMME

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Attachment

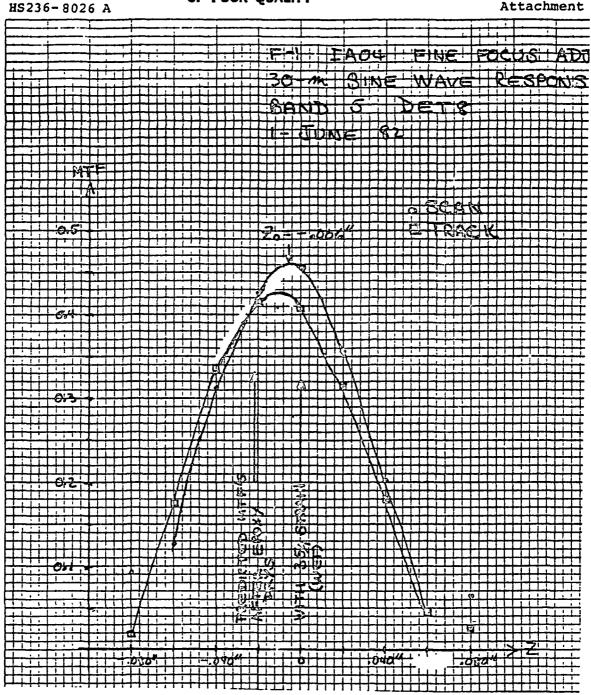


FIGURE 1 FINAL FOCUS TEST

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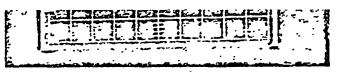
HS236-8026 A

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Attachment 2

BAND NO.	X-DISPLACEMENT (IFOV's)	Y-DISPLACEMENT (IFOV's)
1	+.056	+.326 *
4	.000	.000
7	070	132
5	099	+.099 **

- * This out of spec condition covered by approved Waiver W-126
- ** Erroneously shown as -.099 in HS236-8026
 - TABLE I. Displacements of Bands from Their Nominal Positions in IFOV's (X is the track direction and Y is the scan direction)



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William ...

SANTA BARBARA RESEARCH CENTER A Subsidiary of Hughes Aircraft Company

INTERNAL MEMORANDUM

TO: TM Distribution CC:

DATE: 16 June 1982

REF: HS236-8C33

Systems Test Reports

SED-125

SUBJECT: IA04 MTF/FOCUS & CFPA/PFPA BBR

FROM: E. M. Kelly

· TEST RESULT SUMMARY, TM Flight Model

BLDG. B11 MAIL STA. 101

EXT. 6378

REFERENCES

- 1. TP32015-504(C), Cold Focal Plane Fine Focus and Band-to-Band Registration (IA04R).
- 2. History Tapes #D03020 thru D03029.
- BTCE #2 Event Log for Period 15 May 1982 thru 21 May 1982, and 28 May 1982 thru 3 June 1982.
- Brandshaft, D. G., "IA04R Preliminary Test Results," HS236-8026 dated 14 June 1982.

SUMMARY

This report contains the key results of the MTF/Focus and the CFPA/PFPA BBR sections of IA04R tests, performed from 15 May thru 21 May 1982, and from 28 May thru 3 June 1982, per Test Procedure TP32015-504(C).

The results of the Pre-pinning Tests (Para. 5.1.6 thru Para. 5.5.16) were used for the determination of:

- 1. Fine Focus of Band 5.
- Proper Band-to-Band Registration (BBR) of CFPA to PFPA, with appropriate Radiative Cooler (RC) z-axis rotational adjustments, using the special RC Adjustment Tool Assembly (#78196).

The results of the Post-pinning Tests (Para. 5.9 thru Para. 5.12.23) were used to:

- Verify fine focus of Band 5 was maintained after the RC drilling and pinning operation.
- 2. Determine whether any further inchworm (IW) adjustments

HS236-8033

16 June 1982 Page 2 はいっていることがあることがあるというないというないできます。これは、これではないというないないのである。

SUMMARY (continued)

Verify appropriate BBR has been obtained (i.e., <4 microradians).

OBJECTIVES

The initial objective was to place the CFPA within 0.002* of the cold focal plane.

The final objective was to place the CFPA within \pm 0.001" of the cold focal plane; then to trim the CFPA to PFPA Band to Band Registration (BBR) in cross and along track directions (i.e., for an offset to be \leq 0.00043"), by use of inchworm adjustments.

TEST CONFIGURATION DOCUMENTATION

The tests reported herein are integration-level tests performed on the Thematic Mapper (TM) Optical Assembly to establish final lateral and angular positioning of the Radiative Cooler Assembly, and to achieve optimum focusing of the CFPA (but not including Band 6).

The tests were conducted with the SMA/TM Telescope/Aft Optics Assembly/ and Radiative Cooler mounted on the TM Main Frame and oriented to align the optical axes of the TM Telescope and Collimator. The IA04R test configuration is illustrated in Figure 1-1 of the test procedure (TP32015-504C).

Fine focusing of Bands 5 and 7 was confirmed by calculating the Modulation Transfer Function (MTF) of selected detectors. These MTF data were maximized by inchworm adjustments of the spherical relay mirror.

Following the pinning of the Radiative Cooler Assembly to the Radiative Cooler Adapter and the Telescope Assembly, final CFPA to PFPA registration was achieved by additional adjustments of the three inchworms.

TEST RESULTS

This section summarizes the data which resulted from running each part of the IAO4R test procedure (both the MTF/Focus and the CFPA/PFPA BBR tests). Table 1 summarizes the series of the MTF/Focus tests and their test conditions. This table lists each test by name and its paragraph in the IAO4R test procedure. As noted in

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HS236-8033

16 June 1982 Page 3

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TEST RESULTS (continued)

the table, "Z-axis Focus Range" and "Z-axis Steps" refer to motion of the MTF Wheel from its "Home" position at the Focal Plane of the Collimator. The "Collimator to TM Alignment" column lists the location in the TM Prime Focal Plane with which the Collimator axis is aligned during each MTF/Focus test. This alignment was adjusted by rotating the TM on its Azimuth Table.

Appendix A contains a copy of the ocilloscope photos placed in the Data Master; the tabulated MTF values may be compared with the SWR values which may be obtained from these scope traces. Tables 2 through 8 summarize the results of the remaining MTF/Focus test sequences. Figures 1 through 7 contain plots which were derived from this last group of MTF/Focus tables.

Essentially all BBR confirmation data was obtained by use of Detactors 1, 7 and 15 and Bands 1, 4, 5 and 7. Band 4, Detector 7 served as the scan-coordinates reference center.

Post-adjustment measurement data are tabulated in Tables 9 and 10, according to the direction of measurement. Figure 8 graphically displays the residual mis-registration of detector centers relative to a nominal grid.

Band 1-to-Band 4 mis-registration appears to be 0.056 IFOV in the along track direction and 0.326 IFOV in the cross track direction.

Band 4-to-Band 7 mis-registration appears to be 0.070 IFOV in the along track direction and 0.132 IFOV in the cross track direction.

Band 5-to-Band 7 mis-registration appears to be 0.029 IFOV in the along track direction and 0.231 IFOV in the cross track direction (see Reference #4).

DISCUSSION AND CONCLUSIONS

Pre-Pinning

On 15 May 1982 the initial IA04 Coarse Focus (IA4CFF.DSL) test was run, after emergency updating the (IA4CFF) command files for Detector 8 in Band 5; Detector 9 was not reliably operative at this time. Peak Modulations were:

Cross Track = +0.005"

Along Track = -0.014"

On 17 May 1982 we repeated the IA04 Coarse Focus (IA4CFF.DSL) test, for verification of the above initial test. When it was noticed that this run practically matched the initial run, the Systems/Optics Analyst decided that he had sufficient MTF focus data to

HS 236-8033

16 June 1982 Page 4

DISCUSSION AND CONCLUSIONS

Pre-Pinning (Continued)

determine the magnitude and direction of any spherical relay mirror movement required. Peak Modulations were:

Cross Track = +0.004"

Along Track = -0.012"

The BBR portion of IAO4 test procedure was started on 18 May 1982; this was the Cold Focal Plane to Prime Focal Plane Registration (Para.5.5 of TP32015-504C). Inchworms were stepped as follows:

- (a) I.W. #1 extended 10 steps (2-0.005" in "x" direction)
 I.W. #1 contracted 33 steps(2+0.012" in "x")
- (b) I.W. #2 contracted 5 steps(\(\frac{z}{-0.003}\)" in "x")
 I.W. #2 extended 23 steps (\(\frac{z}{+0.016}\)" in "x")
- (c) I.W. #1 extended 46 steps (2-0.025" in "x")
- (d) I.W. #2 contracted 27 steps(~-0.016" in "x")
- (e) I.W. #3 extended 10 steps (~+0.0010")
 I.W. #3 contracted 10 steps(~+0.0004")

then (f) I.W. #2 was contracted so that the x-position 1/2 power point for Band 5 Detector 7 was near -.1325" in "x" direction (same as for Band 4 and Band 1, Detector 7).

Then the Hx and Hy collects were performed successfully, confirming that no additional rotation of Radiative Cooler was required.

The final (BBR) Hy collects were completed on 20 May 1982.

Note: Radiative Cooler and Adapter reinstalled onto Mapper 24 May 1982. Specific Pre-Pinning(Initial I.W.Move) focus test results are shown in Tables 2 and 3.

Post-Pinning

On 28 May 1982 we ran the IA04 Coarse Focus (IA4CFF.DSL) test, in lieu of Band 5 Fine Focus Test of Para. 5.9, since the IA04 Coarse Focus test has proven so reliable. Peak Modulations were:

Cross Track = +0.011"

Along Track = 0.000"

HS236-8033

16 June 1982 Page 5

DISCUSSION AND CONCLUSIONS

Post-Pinning (Continued)

On 29 May 1982 we fine tuned the CFPA focus by moving all three (3) Inchworms, one at a time. In all, we moved:

I.W. #1 60 extend steps

I.W. #2 31 extend steps

I.W. #3 40 extend steps

Specific Post-Pinning (2nd I.W.Move) focus test results are shown in Table 4.

To verify the above fine focus adjustments, we ran another IA04 Coarse Focus (IA4CFF.DSL) test on 29 May 1982. Peak Modulations were:

Cross Track = +0.004*

Along Track = -0.010"

Also on 29 May 1982 we ran an IAOl Coarse Focus (IAlCFF.DSL) test, for peak MTF comparison of Band 4 Detector 9 versus Band 5 Detector 8, and versus previous IAOl tests. Peak Modulation was:

Cross Track = +0.016"

Note: This peak MTF differed considerably with that of the previous IAO1 test results of +0.004" (taken back on 9 April 1982).

Also see 1 June 1982 data entered below and on Page 6 of this document.

On 1 June 1982 we ran another IA04 Coarse Focus (IA4CFF.DSL) test to verify 29 May runs. Peak Modulations were:

Cross Track = -0.006"

Along Track = -0.010"

These MTF peaks agreed favorably with those anticipated by the Inchworm movements, compensating for the microstrain of the Thematic Mapper carbon epoxy at dryout.

Also on 1 June 1982 we again ran an IAO1 Coarse Focus (IA1CFF.DSL) test for peak MTF comparison of Band 4 Detector 9 versus Band 5 Detector 8, and versus previous IAO1 tests. Peak Modulation was:

Cross Track = +0.006"

This MTF peak nearly agreed with the peak MTF's from IA01 Post-Shim

HS236-8033

16 June 1982 Page 6

DISCUSSION AND CONCLUSIONS

Post-Pinning (Continued)

tests, where the Peak Modulations were:

Cross Track = +0.007" (Band 2 Det. 9)

Cross Track = +0.007" (Band 3 Det. 9)

Cross Track = +0.004" (Band 4 Det. 9)

On 3 June 1982 Appendix K (Inchworm Operation) was successfully performed:

Contracted I.W. #3 one step ("y" direction)

Then final Hx and Hy collects were performed successfully.

Specific final Post-Pinning focus test results are shown in Tables 5 through 8.

> want H. Kelly E. M. Kelly Test Director

D. G. Brandshaft

Systems Engineer/Optics Analyst

Approved by:

G. S. Plews, Manager

Systems Integration & Test

Release Approval:

L. Engel, Manager

Systems Engineering Dept.

EMK:pg

Attachments: 23 + Distribution for IA04

HS236-8033

16 June 1982 Attachment 1

TABLE 1
Summary of IAO4 MTF/Focus Tests

TP PARA.	TEST NAME	1982 DATE	B/D USED	Z-AXIS STEPS	Z-AXIS FOCUS RANGE	COLL.to TM ALIGNMENT
PRE-RC P	INNING:					
5.1.6	"SCOPE PHOTOS"	5/15	5/8	-	<u>+</u> 0.040*	ON-AXIS
	"SCOPE PHOTOS"	5/15	5/8	-	±0.080"	ON-AXIS
5.1.7	CF (CT, AT)	5/15	5/8	.020"	<u>+</u> 0.080"	ON-AXIS
5.1.7	CF (CT, AT)	5/17	5/8	.020"	±0.080"	ON-AXIS
POST-RC 1	PINNING: CF(CT,AT)	5/28	5/8	.020"	+0.080"	ON-AXIS
1. W. FOO	CUS MOVE: (5/29/82	!)				
5.10	MOVED I.W. #1	60 EXT	END STEP	S		
	" I.W. #2	31	, ,			
	" I.W. #3	40				
POST- I.W. MOVE:						
5.11	CF(CT,AT)	5/29	5/8	.020"	<u>+</u> 0.080"	ON-AXIS
	*CF(CT)	5/29	4/9	.010"	+0.040"	ON-AXIS
5.11	CF (CT,AT)	6/1	5/8	.020"	<u>+</u> 0.080"	ON-AXIS
	*CF (CT)	6/1	4/9	.010"	+0.040"	ON-AXIS

*NOTE: Above Band 4 Detector 9 tests were run for comparison only

HS236-8033

16 June 1982 Attachment 2

TABLE 2

INITIAL PRE-PINNING COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 5 DETECTOR 8)

Z-POSITION	CT MTF	AT MTF
+.080"	.0190	.0478
+.060"	.1403	.0816
+.040"	.3016	.1884
+.020"	.4231 ·	.2970
.000"	.4655	.3891
020"	.3752	.4124
040"	.1840	.3564
060*	.0555	.2168
080*	.1572	.0853

DATA COLLECTION: DATE/TIME: 15 May 1982/15:20 & 16:20

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TABLE 3

FINAL PRE-PINNING COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 5 DETECTOR 8)

Z-POSITION	CT MTF	AT MTF
+.080"	.0136	.0840
+.060"	.1118	.0873
+.040"	.2672	.1900
+.020"	.4196 ·	.3118
.000"	.4770	.4009
020"	.3982	.4148
040"	.2328	.3431
060"	.0501	.2006
080"	.1437	.0934

DATA COLLECTION: DATE/TIME: 17 May 1982/10:30 & 11:30

HS236-8033

16 June 1982 Attachment 4

TABLE 4

INITIAL POST-PINNING COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 5 DETECTOR 8)

Z-POSITION	CT MTF	AT MIF
+.080"	.0533	.0129
+.060"	.1850	.1144
+.040"	.3414	.2285
+.020"	.4404 ·	.3490
.000"	.4383	.4204
020"	.3094	.3653
040"	.1283	.2547
060"	.0792	.0931
080"	.1744	.0478

DATA COLLECTION: DATE/TIME: 28 May 1982/16:00 & 17:00

NOTE: This Post Pinning test was done after the second I.W. Movements.

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TABLE 5

2ND POST-PINNING COARSE FOCUS TEST RESULTS

(30 Meter Bar Pattern)
(Band 5 Detector 8)

Z-POSITION	CT MTF	AT MTF
+.080"	.0484	.0317
+.060"	.0971	.0702
+.040"	.2469	.1973
+.020"	.3952	.3316
.000"	.4643	.4093
020"	.4026	.4118
040"	.2642	.3242
060"	.0898	.1605
080"	.1191	.0230

DATA COLLECTION: DATE/TIME: 29 May 1982/

15:40 & 18:00

NOTE: This Post-Pinning test was the first one done after the Inchworms were moved to fine tune the CFPA focus.

HS236-8033

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16 June 1982 Attachment 6

TABLE 6

3RD POST-PINNING COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 4 DETECTOR 9)

Z-POSITION	CT MTF
+.040"	.3131
+.030"	.3990
+.020"	.4380
+.010"	.4564
.000"	.4329
010"	.4071
020"	.3152
030"	.2264
040"	.1535
M.	

DATA COLLECTION: DATE/TIME: 29 May 1982/16:15

NOTE: Above test was for peak MTF comparison only.

HS236-8033

16 June 1982 Attachment 7

TABLE 7

4TH POST-PINNING COARSE FOCUS TEST RESULTS

(30 METER BAR PATTERN)

(BAND 5 DETECTOR 8)

Z-AXIS	CT MTF	AT MTF
+.080"	.0655	.0275
+.060"	.0493	.0450
+.040"	.2031 .	.1586
+.020"	.3590	.3145
.000"	.4543	.4079
020"	.4262	.4161
040"	.3133	.3373
060"	.1272	.1758
080"	.0924	.0194

DATA COLLECTION: DATE/TIME: 1 June 1982/ 14:35 & 16:35

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TABLE 8

5th Post-Pinning Coarse Focus Test Results

(30 Meter Bar Pattern)
(Band 4 Detector 9)

<u>z-AXIS</u>	CT MTF
+.040"	.2730
+.030"	.3494
+.020"	. 4193
+.010"	.4485
.000"	.4475
010"	.4204
020"	.3742
030"	.2706
040"	.1807

DATA COLLECTION: DATE/TIME: 1 June 1982/13:40

NOTE: Above test was for Peak MTF comparison

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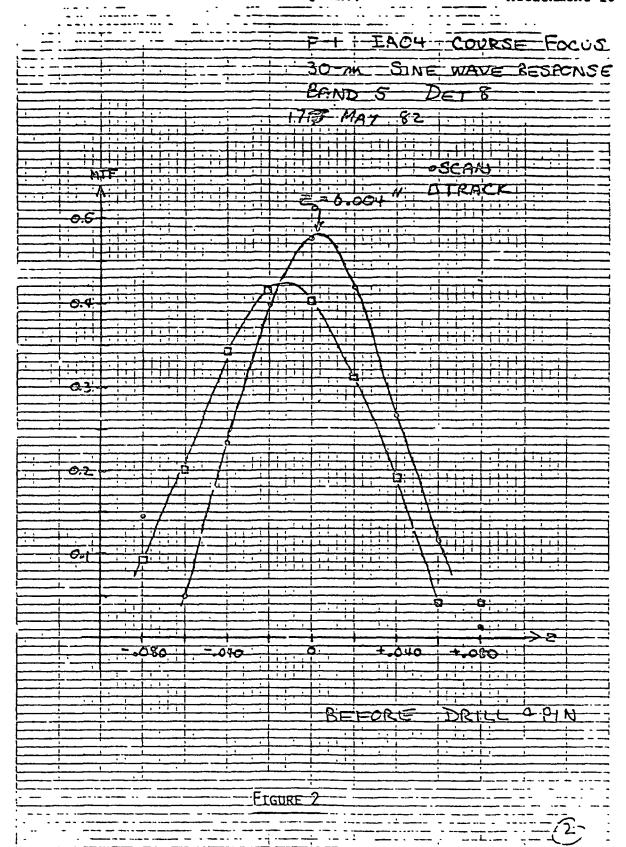
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16 June 1982 Attachment 9

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FIGURE 4		

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- FIGURE 6

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mb = 3 0 - 6 0 3 3	POLAROID PRINT DATA	CARD
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TEST DESCRIPTION: SCOPE	PIHITOS	DATE: 5-45-82 TIME: 14:35
0-1007-115		TRACES: 1. Ball Det B 2 Co Hang (10000°) 2 CROSS - TRACK 3 STING V = SV/Com HORIZ TIME: NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENT
F-1-	[AP4 -1	(CRUSS TRACK)
	POLAROID PRINT DATA	CARD
	REV:	DATA STORAGE NO:
TEST TECHNIQUE: 78 \$2015-,504	SUB-STEP	DATA REF. NO:
TEST DESCRIPTION:		DATE: 5-15-82 TIME: 14:35
		TRACES: 1. Band 5 Det 8 2

HORIZ, TIME:

ORIGINAL PAGE IS 16 June 1982 OF POOR QUALITY HS236-8033 Attachment 17 POLAROID PRINT DATA CARD _ REV: ___ DATA STORAGE NO: ___ TEST TECHNIQUE: TPS 2015- 37 4 SUB-STEP C DATA REF. NO: __ . SUP & PHOTOS DATE: 5-15-92 TIME: 14:45 TEST DESCRIPTION: ... 1. Band 5 Det 8 Z@ +0.080° Suc V = 5 V/c-HORIZ, TIME. ___ NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENTS 0-1007-115 (CROSS TRACK) F-1 IADY POLAROID PRINT DATA CARD DATA STORAGE NO: __ TEST TECHNIQUE: TP32015-584 SUBSTEP C DATA REF. NO: __ DATE. 5-15-82 TIME: 1455 TEST DESCRIPTION: _ TRACES: 1. Band 5 Det 8 Z @ - 0.080° SXNC V- 5 V/cm

HORIZ TIME. _____

ORIGINAL PAGE IS OF POOR QUALITY 16 June 1982 HS236-8033 Attachment 19 POLAROID PRINT DATA CARD PROC. BK. __ DATA STORAGE NO: ___ TEST TECHNIQUE: 7732015-504 SUB-STEP _ DATA REF. NO: ___ DATE: 5-15-82 TIME: 16'10 TEST DESCRIPTION: ___ SCOPE PHOTOS TRACES: 1. Band 5 Det 8 Z @ HONO (+0.0180) des2 - 797 SUNCE H = 5 V/cm HORIZ TIME: _0./ sig. NOTE: USE REVERSE SIDE OF CARD FOR ADDITIONAL ENGINEERING COMMENTS 0-1007-115 (ALDNG TRACK) IA04 POLAROID PRINT DATA CARD POATA STORAGE NO: __ TEST TECHNIQUE: TP 3 2615-504 SUB-STEP C DATA REF. NO: -DATE: 5-15-82 TIME: 1616 TEST DESCRIPTION: _ TRACES:

425V/Cm

PROC. 8K:	OF POOR	POLAROID PRINT	
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	TEST	
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CFPA/PFPA BBR STATUS

Attachment 21

16 June 1982

-0.032796

15

-0.032659

0.025088

0.000779

15

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0.000000

0.024546

0.00000

0.032640

-0.024480

0.032640

0.008160 -0.024480

-0.031585

Measured Center Displacements are from nominal center values, relative to the

Reference Detector (Band 4 Det, 7) location.

šš:

0.008160

-0.024480

-0.031530

0.032640

0.025128 0.000840

-0.007512 -0.007320 -0.007050 *Nominal Center includes (2) IFOV offset (+.00816") due to using Band 4 Det.9

Reference Detector Offset = 0.008031 in PFPA inches.

data base for Band 4 Det.7.

Above data taken from COVEST. RED; 5 data printout.

σ

TABLE

-0.008179

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-0.008094

-0.008316

-0.008276 -0.008306

(PFPA inches)

0.008160

-0.024480

0.032640

0.024364 -0.000146

from Band 4 Det.7

(PFPA inches)

*Nominal Center

Measured Detector Center

from Band 4 Det. (PFPA inches)

Detector

Band

IA04 POST SHIM DATA OF 3 JUNE 1982

X-DIRECTION (ALONG TRACK)

Measured Center Displacement

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CFPA/PFPA BBR STATUS TM FLIGHT MODEL - IA04 TEST RESULT SUMMARY:

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Y-DIR	POST
	IA04

 	ļ				ORI	iginal Poor	P# Ql	IGE JAL	IS ITY				
Measured Center Displacement (PFPA inches)	0.001390	0.001422	0.001468	0.000135	000000000	0.000156	0.000604	0.000544	0.000360	-0.000310	-0.000406	-0.000610	
Nominal Center from Band 4 Det. 7 (PFPA inches)	0.306000	0.306000	0.306000	0.00000	0.00000	0.00000	-0.289680	-0.289680	-0.289680	-0.183600	-0.183600	-0.183600	
Measured Detector Center Nominal Center from Band 4 Det. 7 from Band 4 Det (PFPA inches)	0.307390	0.307422	0.307468	0.000135	0.00000	0.000156	-0.289076	-0.289136	-0.289320	-0.183910	-0.184006	-0.184210	
Detector	1	7	15	-	7	15	7	7	15	1	7	15	

Medsured Center displacements are from rominal center values, relative to the Reference Detector (Band 4 Det.7) location.
Reference Detector Offset = -0.000309 in PFPA inches.
Above data taken from COVEST.RED;12 data printout.

TABLE 10

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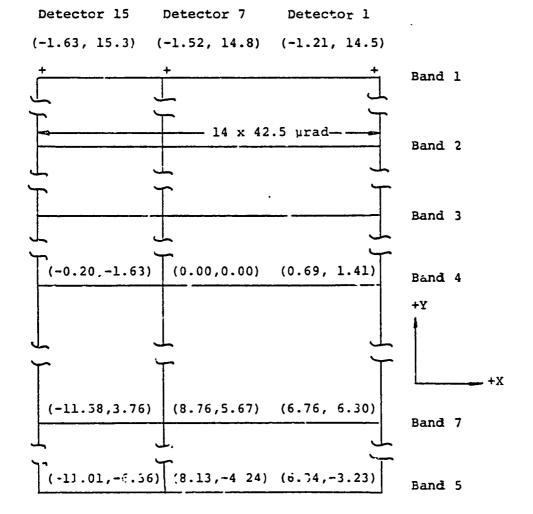
16 June 1982 Attachment 23

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TM FLIGHT MODEL TEST RESULT SUMMARY

CFPA/PFPA BBR STATUS

BBR STATUS IA04R POST SHIM DATA OF 3 JUNE 1982



Notes: (a) Coordinates are deviations from IDEPL Channel Center locations, relative to B4,D7, and normalized for (2) IFOV delta of Table 9.

SANTA BARBARA RESUARCH CENIER A Subuday of Highes Aircraft Company

INTERNAL MEMORANDUM

70: G. Plews

IA03R Coarse Pocus

Focal Plane

Determination, Cold

subject.

U. J. Campbell

R. Dick

E. Kelly

F. Nicholas

T. Sciacca

D. Young

Data Bank (6)

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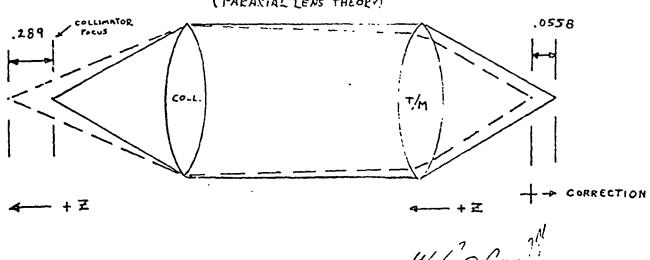
INT 6373

The Thematic Mapper cold focal plane best focus position was found to be .289 + Δ Z from the collinator best focus (long focus), or a .0558 + Δ Z at the T/M cold focal plane (short focus). This dimension was determined by the following formula:

Relay Optics System E.F.L. \times Z Focus Error at Collimator Focus = Collimator E.F.L. Focus Error at Cold Fecal Plane, or: $\left(\frac{48}{109.225}\right)^2 \times .289 = .0558 + \Delta Z \text{ Focus Error (Short)}$

Correction: Shim Increase (- 42)

(PARAXIAL LENS THEORY)



W., J. O'Donnell

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3.2.4 IA06 TEST

Verification of Telescope Orientation to SMA
Pivot Axis

Test Summary: HS236-7926 C.J. Kent

Test Specification: TP32015-506 Scan Mirror to Radiometer

Alignment Procedure

Reference Documentation: None

SANTA BARBARA RESEARCH CENTER A Subsidiary of Hughes Aircraft Company

INTERNAL MEMORANDUM

TO: J. L. Engel

CC: Optics File
Data Bank (3)
Distribution

DATE: 1 April 1982

REF: 2221-548 HS236-7926

SUBJECT: T.M. Flt. IA06

Test Result Summary

FROM: C. J. Kent & IA06

Test Report Committee

BLDG. B11 MAIL STA. 78

EXT. 6268

References: 1) TP32015-506; Rev. D - Scan Mirror to Radiometer Alignment Test Procedure

2) History Tapes: D03013, D03014, D03015

3) [324,1] DIRECTORY.DIR; 43 Master Directory of Data Bases

4) [324,1] DIRECTORY.DIR; 45 Master Directory of Data Bases for Coarse Focus Check

5) BTCE #2 Event Log for Period 25 March 1982 through 27 March 1982

6) [322,1] IO60PV.RED - Reduced Data for Band 1 Detector 9 and Band 4 Detector 9 Open Pattern Value Collects

7) [322,1] IO60PV.IVF - Intermediate Value File for Open Pattern Value Collects

8) [322,1] IO60PQ.RED - Reduced Data for Band 1 Detector 9 and Band 4 Detector 9 Opaque Value Collects.

9) [322,1] IO60PQ.IVF - Intermediate Value File for Opaque Value Collects.

10) [322,1] COVEST.RED - Reduced Data for Index H X Axis Collects Band 4 Detector 9 and Band 1 Detector 9

11) [322,1] CHNCTR.IVF - Intermediate Value File for Index F Collects

12) [322,1] BARYSCN.VID - Video Data Files for Scan Action to Reticle Bar Alignment.

13) TM System Test Log, Book F-1, Pages 043-049

1.0 INTRODUCTION

The following report provides the results of performing the IA06R Test, "Scan Mirror to Radiometer Alignment Test Procedure" on the Thematic Mapper Flight-1 Model (F-1). This test was an integration and alignment level tack, performed on the F-1 which was assembled to the level of F-1 assembly, P/N 51065 less sunshade, radiative cooler and adaptor, electronics module, and thermal blankets. Test objectives are detailed in the requirements document HS236-5855 and HS236-5799. The overall objectives included the three following tasks:

- 1. Image quality measurements were to be made before and after any Telescope Assembly adjustment to allow assessment of system MTF degradation (as a result of pernuting primary mirror strain).
- 2. Alignment of the Prime Focal Plane Array's Along-Scam direction to the Scan Mirror's scanning action was to be accomplished within an error angle of +/- 0.5 mr.
- 3. Scan Mirror Centration, relative to the system aperture stop (baffle B10) was to be determined by taking measurements at 4 points (in the plane of the mirror), namely margins at +/- x and +/- y.

1 April 1982 2221-548 HS236-7926

J. L. Engel

-2-

T.M. Flt. IA06 Test Result Summary

2.0 TEST REPORT

This report is partitioned according to the three main test objectives.

Focal Plane Alignment to Scan Mirror Action: The procedure for accomplishing focal-plane to scan-mirror alignment involved 3 distinct sub-tests:

- Orientation of a reference reticle edge parallel to the collimator's y-axis;
- 2. Orientation of the scan mirror's pivot axis to be perpendicular to the reference reticle edge; and
- 3. Measurement of the SiFPA-to-edge aspect angle, followed by Optical Assembly rotation, and remeasurement, until the specified angle limit was met.

Attached Figures 2, 3, and 4 illustrate the sensor/edge relationship, the relative motion between sensor and edge, and the error angle of interest for each of the above sub-tests. Figure 2 shows the translation stage moving a misaligned reticle past a stationary detector; Figure 3 shows a detector being translated along the edge (now aligned to the collimator's y-axis) due to scan-mirror motion; and Figure 4 shows an x-direction scan with the reticle edge to reveal differences in x-coordinates of common numbered detectors in Bands 1 and 4.

The residual angles from operations (2) and (3) add algebraically to provide the final alignment error, while the error from (1) provides only a cosine effect on the measurement of the error in (3). It tends to exaggerate the measurement in (3).

The following theta-z errors (TZEn) were measured at the conclusion of each step noted above:

- 1. TZE1 (Coll. y-axis to reticle edge) = 0. mr
- 2. TZE2 (reticle edge to scan action) = 0.01 (+/-.02) mr
- 3. TZE3 (reticle edge to SiFPA Along Scan) = 0.74 (+/- .03) mr

The uncertainty of measurement for these 3 error angles has not been statistically determined; however, various repeat measurements indicate probable uncertainties on the order of the magnitudes reported above. On this basis, the difference: TZE2 - TZE3 = .75 (+/- .05)mr is the final SMA to SiFPA alignment error. The error is greater than the 0.5 mr specification.

TZE2 - TZE3 = TZA = .75 (+/- .05) mr

1 April 1982 2221-548 HS236-7926

J. L. Engel

-3-

T.M. Flt. IA06 Test Result Summary

On a systems level, TZA contributes to the along track band to band registration error. For TZA = 0.75 mrad, this contribution amounts to 0.06 IFOV along track mis-registration between bands 1 and 4. The system level specification is \pm 0.2 IFOV. The current value of TZA will not affect our ability to meet this specification.

If the cold focal plane arrays (CFPA's) are aligned to the warm focal plane rather than to the scan direction, the current value of TZA will result in an along track misregistration between bands 1 and 5 of 0.12 IFOV. If the cold focal plane is aligned to the scan direction, T'A will not influence the warm to cold focal plane band to band registration. In either event, the error in TZA is not large enough to affect our ability to meet the systems level specification of less than 0.3 IFOV.

Therefore, no attempt was made to rotate the telescope housing in order to reduce TZA. Waiver W148 has been submitted and accepted in lieu of rotating the telescope housing.

Image Quality Check: Pre-/Post-adjustment measurements in this section were not required since rotation of the telescope housing was not necessary.

Scan Mirror Centration: The Protoflight Model Scan Mirror Substrate is an ellipse 21.10 ± 0.01 inches x 16.30 ± 0.01 inches with a clear aperture extending to within 0.030 inches of the mirror edge. If there is no edge rolloff within the aperture and if centering errors are zero, the mirror margins exceed 0.1 inch for extreme Band 1 and 6 field angles when the Scan Mirror is at its maximum scan angle (38.85 degrees).

The data in Table 3 indicate that edge margins are adequate in the \pm X and \pm Y directions (see also Figure 5, attached).

CLEAR APERTURE SCAN MIRROR ANGLE RAY HEIGHT (inches) SCAN MIRROR MARGIN(inches) MODELED MEASURED ESTIMATED (deg) Y X 35.00 (1) +8.0 0.0 0.672 0.667 ---35.00 (1) -8.0 0.0 0.608 0.601 ---(2) 0.0 +8.0 0.146 0.137 (2) 0.0 -8.0 0.146 0.132 38.58 (3) +8.0 0.0 0.114 0.107 38.62 (4) -8.0 0.0 0.111 0.101

Table 3. Scan Mirror Centration

- (1) For field angle associated with central LED (-0.0200 deg)
- (2) For field angle associated with end of band (0.0195 deg)
- (3) For field angle associated with extreme Band 1 (+0.2122 deg)
- (4) For field angle associated with extreme Band 6 (-0.2492 deg)

J. L. Engel

-4-

1 Apr11 1982 2221-548 HS236-7926

T.M. Flt. IA06 Test Result Summary

Test Records: All pertinent Video Files, Intermediate Value Files, Command Files, and Data Bases have been saved on the referenced History Tape.

3.0 CONCLUSIONS

The scan mirror-to-PFPA alignment for the Thematic Mapper Flight-1 Model has been accomplished within system level specification.

Scan mirror centration measurements confirm that the mirror has been installed well within tolerances.

Prepared by:

C. J. Kent, Test Director

Approvel by:

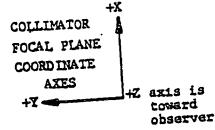
Omald Brandshaft
System Engineering

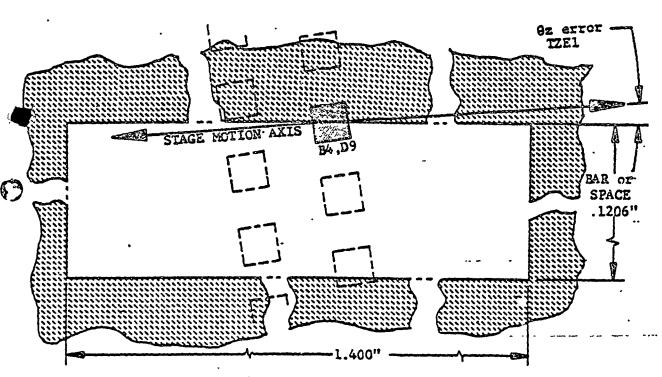
Release Approval by:

Manager System Test

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Attachments (4)





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FIGURE 2

ALIGNING RETICLE EDGE PARALLEL TO Y-AXIS STAGE TRAVEL:

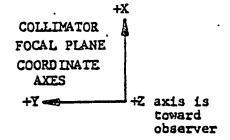
Reticle is translated by stage motion as shown; any change in Band 4, Det.9 output reveals angular error.

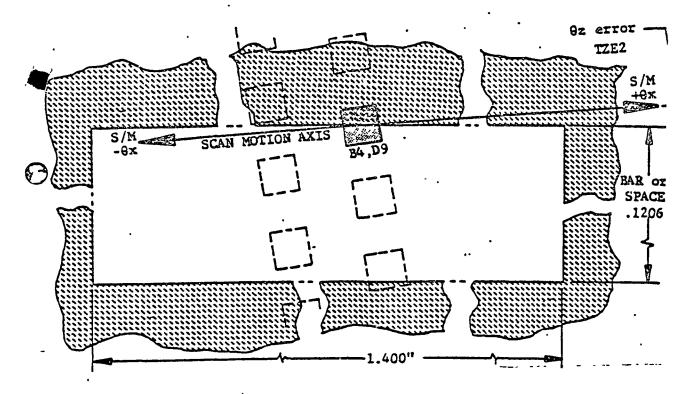


IA06 Test Summary (HS236-7926)

Attachment B .

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FIGURE 3

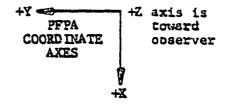
ALIGNING SCAN MIRROR ACTION TO RETICLE EDGE:

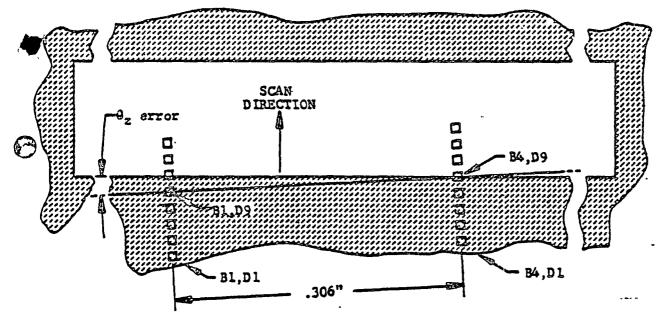
As the Scan Mirror rotates thru full forward and reverse scans, relative detector-to-edge motion occurs along the axis shown; any change in detector output reveals angular error.

IA06 Test Summary (HS236-7926)

Attachment C

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FIGURE 4

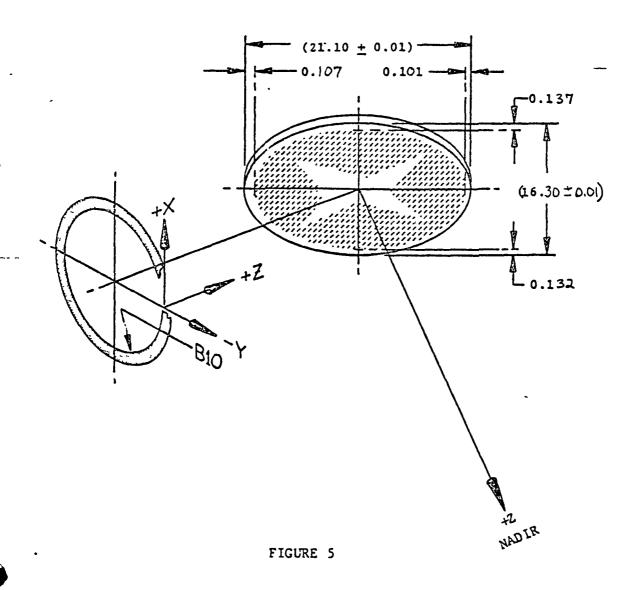
ALIGNING PFPA'S ALONG-SCAN DIRECTION TO RETICLE EDGE:

The x-axis stage steps the reticle (-X) across common numbered detectors to develop edge traces from which a Δx between detector centers can be determined; the error angle is then TXE3 = $\Delta x/\Delta y$, where Δy is the separation between bands used.

IA06 Test Summary (HS236-7926)

Attachment D

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SCAN MIRROR CENTRATION MEASUREMENTS